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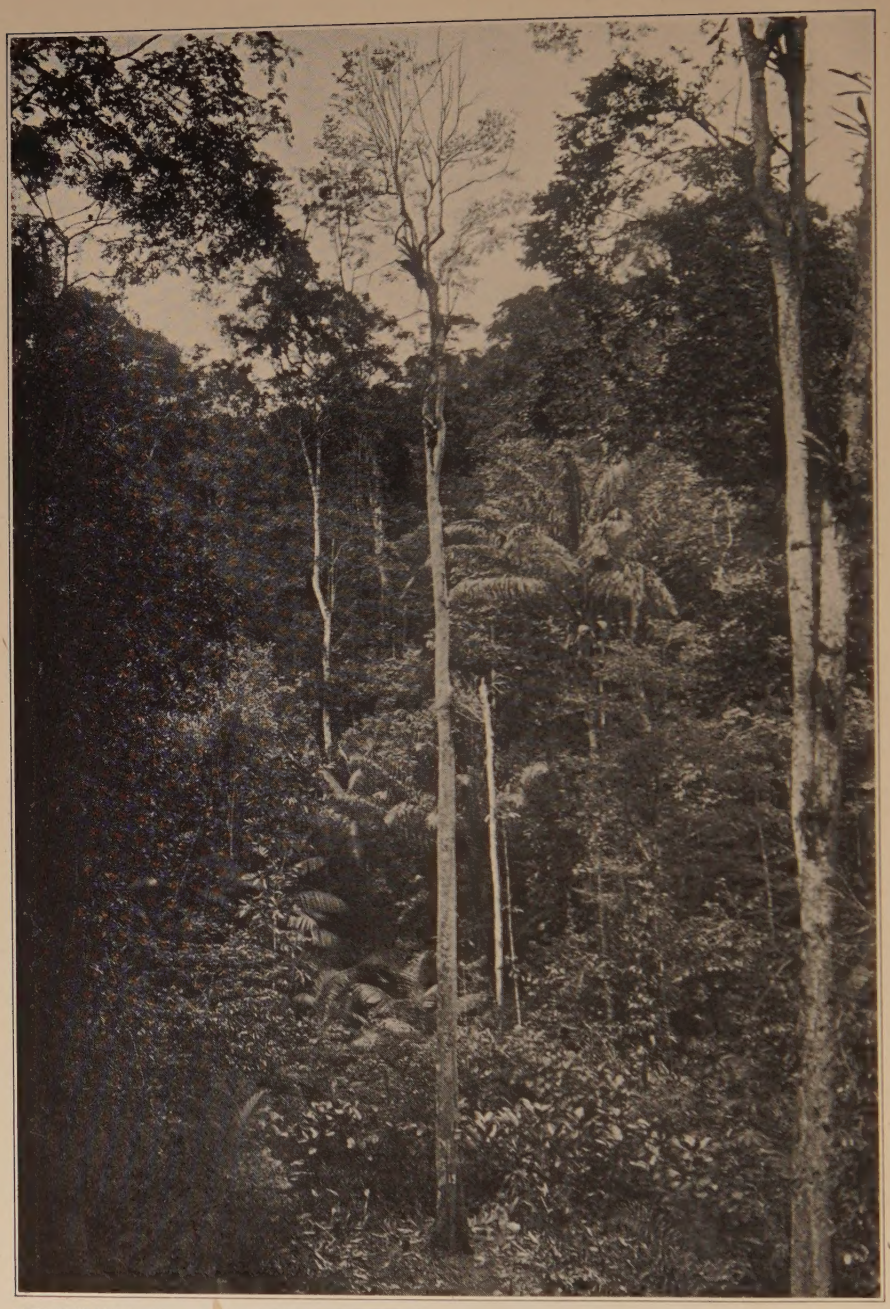

PHOTOGRAPH BY J. W. GONGGRIJP, SURINAM

IN THE HEART OF A TROPICAL FOREST

TIMBERS OF TROPICAL AMERICA

BY

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The present volume is the fourth work published by the Yale University Press on the Amasa Stone Mather Memorial Publication Fund. This Foundation was established August 25, 1922, by a gift to Yale University from Samuel Mather, Esq., of Cleveland, Ohio, in pursuance of a pledge made in June, 1922, on the fifteenth anniversary of the graduation of his son, Amasa Stone Mather, who was born in Cleveland on August 20, 1884, and was graduated from Yale College in the Class of 1907. Subsequently, after traveling abroad, he returned to Cleveland, where he soon won a recognized position in the business life of the city and where he actively interested himself also in the work of many organizations devoted to the betterment of the community and to the welfare of the nation. His death from pneumonia on February 9, 1920, was undoubtedly hastened by his characteristic unwillingness ever to spare himself, even when ill, in the discharge of his duties or in his efforts to protect and further the interests committed to his care by his associates.

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PREFACE

Tropical America is approaching an era of great development. The barriers, real and imaginary, which have served to divert so much of the westward tide of civilization to the temperate regions are being rapidly broken down by the scientist and the engineer. The vast domain, with its untold wealth of natural resources, is being explored, and railways are in process of construction or under consideration which eventually will afford ready access to the hinterlands beyond the present fringe of settlements. There is land for grazing and for the growth of a rich variety of crops, and there are stores of oil and minerals, unlimited water power, and enormous timber wealth. These natural resources, scarcely touched by man, await the time when the growing needs of the world will make their exploitation profitable.

The people of the United States are just awakening to the realization that their virgin forests, supposedly inexhaustible, are nearly cut over. Heretofore, as region after region was logged of its choice timber, the lumbermen have moved on to new fields, and as transportation facilities kept pace with their advance they have been able to supply the demand from any portion of the country, however remote. As a result there has been no actual scarcity of lumber on the market, but there has been an inevitable increase in price as well as the introduction of new kinds of woods and a lowering in grades.

There will always be an adequate supply of certain qualities of timber in the United States, but there is a definite limit to the class of material which only the virgin forest produces. The American timber of the future will be of the quality now known as second-growth. These changing conditions will greatly stimulate forestry practice, but such measures have been too long delayed to meet the situation that is developing. Already a shortage of special classes of hardwoods is being felt, and, inasmuch as some of the most useful of these are poorly adapted to forestry methods because of their slow growth, the industries dependent upon them are beginning to look for substitutes. Attention is naturally being directed to the forests of the tropics.

Over large portions of tropical America the forest consists of mixed hardwoods yielding some five or six thousand board feet per acre. In some localities, however, where the climatic and soil conditions are favorable, there are stands of 25,000 to 30,000 feet, in very exceptional instances up to 100,000 feet, per acre. The number of species in mixture is usually large, but the complexity is greatest among the smaller tree

growth comprising the lower stories of the forest, while the dominant trees, usually the most valuable for lumber, are of comparatively few kinds in a given region. In many instances there are nearly pure stands of commercial timbers, as for instance in the case of crabwood in Venezuela and the Guianas, mora and possum wood in Surinam, quebracho in the Argentine and Paraguayan Chaco, and various other examples which might be cited. In many other regions single species predominate over large areas: for example, "espavé" in Panama, guanacaste and chicle in Mexico, "albarco" or Colombian mahogany in Colombia and Venezuela, "peroba rosa" in São Paulo, Brazil, "lapacho" in Argentina, "wallaba" and "angelin" in the Guianas, "santa maría" in parts of Central America, and "páo mulato" and representatives of the Brazil-nut family in the Amazon region. In such stands modern logging methods may be successfully employed under proper supervision, though so many failures have resulted from such attempts in the past, particularly in highly selective logging, that many operators prefer the primitive native methods or some modification of them. It is well for prospective operators to realize that tropical logging is beset with difficulties peculiar to the region and that the successful overcoming of them calls for a high degree of tact and skill.

When it is stated that tropical forests consist almost entirely of hardwoods it should be understood that the term is used in a technical sense, or as opposed to conifers, and has no reference whatever to the hardness of the wood. There are merchantable quantities of pine in the plateau region of Mexico, portions of Central America, and to a much less extent in Santo Domingo, just as there are considerable areas of the so-called Paraná pine in southern Brazil. These coniferous forests, however, are not typical of the tropics, and the aggregate area occupied by them is relatively very small. They are already being exploited, and there is a ready market for their products.

Some of the tropical American hardwoods have been known to the world's commerce for a long time, but until recently they have been of the cabinet, fancy, or other special kinds, because only these rarer sorts could be handled profitably. This fact has tended to create the erroneous impression that all tropical woods are in this category, whereas, in reality, they exhibit the widest possible range of variation. In the matter of density, there are all extremes from lighter than cork to a third heavier than water. Taking tropical woods in general, about a third of them are in the hard and heavy class, another third light and soft, and the remainder intermediate. Many are richly colored and beautifully figured, but the great majority are plain. A representative collection from any tropical region shows a noticeably large proportion

of general utility woods which have mostly escaped attention, but which have great potential value for all sorts of industrial purposes. Their limited utilization in the past is largely attributable to the competition of pine and fir products from the more highly developed lumber industry in temperate regions.

The tropical timber business of the future, however, will tend more and more toward the non-precious woods which will serve the same purposes as the rank-and-file of our native material. In order to secure the best results the readily available kinds should be carefully investigated to determine the proper methods of handling and utilizing the lumber from the forest to the finished product. One matter of importance is concerned with the seasoning of the lumber to prevent warping, checking, and staining, but what a few years ago seemed an almost insurmountable obstacle is being rapidly overcome by modern methods of kiln-drying. Through years of experience, manufacturers have learned how to handle certain kinds of woods very successfully and are naturally loath to try new ones. The most serious hindrance to the introduction of tropical hardwoods into new fields is the lack of information concerning them. A manufacturer is concerned, not only with the properties of his woods, but also with their source and the probability of continuous supply. Only those who have sought such information realize the difficulty, if not the impossibility, of obtaining it.

This book is designed to meet this need in part, to serve at least as a starting point for more detailed investigations. It had its beginning in 1916, when a Department of Tropical Forestry was established in the School of Forestry of Yale University. The existing tropical collections of the School were greatly increased through the gift of wood specimens and herbarium material, together with a wealth of field notes, publications, and photographs, from Mr. Hugh M. Curran, Collaborator in Tropical Forestry, who for several years previously had been engaged in exploration in the tropics. A systematic and comprehensive study of these collections was begun by Mr. Record and subsequently expanded as additional material became available through further field excursions of Mr. Curran and of Dr. H. N. Whitford, Assistant Professor of Tropical Forestry. Eventually the point was reached in this investigation of tropical American woods where it seemed advisable to publish the results, even though the work could in no sense be considered complete.

The field covered is so vast and the material and literature often so fragmentary that the work is necessarily of the nature of a general reconnaissance, with such attention to details as the subject seemed to warrant or as conditions in a given case would permit. It is hoped, how-

ever, not only that the original contributions and the digest of the available published material will prove helpful, but also that the calling of attention to the many broad gaps in our knowledge and to the chaotic condition of some of the literature and information will serve the useful purpose of stimulating and directing exploration and research on the part of other investigators.

The descriptions of the woods, unless otherwise indicated, are made from specimens in the Yale collections. These specimens are of two general classes, namely, (1) trade or market samples and miscellaneous material obtained without definite information as to the botanical classification, and (2) specimens collected by botanists, foresters, and others, with herbarium material from the same trees so as to permit of positive identification. The Yale collections are rich in material of both classes, the latter furnishing the basis for identifying the former and making it possible to bring together for critical comparison and compilation the existing data which otherwise would remain disconnected and unusable. In several instances where such key specimens were lacking, they were secured through the cooperation of various persons located in or having access to the forests where the trees grew. As an aid in the study of the comparative anatomy of the woods, full use was made of collections from the tropics of the Old World, together with the many excellent reports which have been published on the woods of certain of those regions.

This book is divided into two parts, the first of which deals with the tropical American countries and their forests and is largely in the nature of an introduction to the descriptions of the trees and their woods in the second part. This setting or background is essential to coordinate and give proportion to the detailed descriptions which follow. Part I is exclusively the work of Mr. Mell, formerly Assistant Dendrologist in the U. S. Forest Service and Assistant Pharmacognosist in the U. S. Bureau of Chemistry, later engaged in the tropical timber business in New York City, and more recently doing reconnaissance work on timberlands in various parts of tropical America. His field investigations have taken him into all parts of the West Indies, Mexico, Costa Rica, Panama, Colombia, Venezuela, the Guianas, Brazil, and other parts of South America, thus permitting him to write of these countries with a personal knowledge of their forest conditions. He has also supplied considerable material and data incorporated in Part II. In the main, however, Part II is the work of Mr. Record, and upon him rests the responsibility for the subject matter and its treatment.

PART I.

THE COUNTRIES AND THEIR FORESTS

SOURCES OF INFORMATION

THIS part presents a general view of the tropical American countries with respect to their forests and various factors involved in their exploitation and development. Matters of population, topography, climate, and accessibility are emphasized because, from the standpoint of the utilization of the timber, they are frequently of even greater concern than the nature and extent of the forests themselves.

Until recently the knowledge of the tropical American forests has come from three principal sources: (1) The reports by botanists from the earliest times down to the present; (2) the data secured by travelers and by prospectors for minerals, oil, timber, and other natural resources; and (3) the results of the technical investigations of available wood samples. The first of these is purely scientific and, while it forms the basis for subsequent work, the descriptions of the trees and forests are often so incomplete and the vernacular names of the trees are frequently so confused that it is difficult to correlate this information with that obtained from other sources. The botanist, as a rule, is not interested in the commercial aspects of the forest and, consequently, does not supply much, if any, data regarding the stand and availability of the timber or the quality and usefulness of the woods.

Prospectors, as a class, are not given to writing for publication, but such reports as are available are very useful, as they usually deal with regions not embraced in the itinerary of the ordinary traveler. The information recorded by early travelers in the American tropics is usually concerned largely with the coastal and riparian areas and often give an inaccurate picture of the region as a whole. Nevertheless these early accounts remain, in many instances, the only sources of information of certain regions and must be interpreted in the light of personal experience in similar localities, otherwise very erroneous impressions may be obtained.

More intimate knowledge of tropical American forests is now being secured by trained foresters engaged in extensive reconnaissance, mostly for foreign owners of timber concessions. The forester, by virtue of his technical training in both the scientific and the commercial phases of the situation, can adjust himself promptly to new and unusual conditions, is able to identify the species, make estimates of the stands, and determine the feasibility of logging operations. His work bridges the gap between the scientific specialist on one hand and the so-called practical cruiser or operator on the other. To the lack in the past of such

information as only the competent forester can supply may be attributed the failures of many tropical enterprises involving serious financial loss to investors.

In too many instances the owner of a concession is interested only in disposing of it at a profit and to this end wishes to secure a highly favorable and optimistic report on his property. It is highly significant that such promoters rarely employ trained foresters for such tasks. This is usually left to the investors, and not infrequently is delayed too long to protect them from loss. This is meant in no sense to discourage lumber operations in the tropics, but simply to caution prospective investors first to make sure that they are in possession of all the facts.

The author of this portion of this book has made free use of all available sources of information, but has attempted to interpret the data in the light of his own personal experiences and investigations. Figures of area, population, length of rivers and shorelines, etc., have been taken from the *New World of Today*, by R. Hope Moncrieff (1921). Credit should also be given to various reports published in the *Bulletin of the Pan-American Union*, Washington, D. C. Information dealing directly with the forests of the countries was drawn largely from the author's own field notes. The field covered is a vast one and the treatment is necessarily brief, but it is hoped that the reader will be able to get a fairly definite panoramic view of the tropical American forests and the conditions attending their utilization.

SUMMARY

The forest resources of tropical America may be briefly summarized as follows: The West Indian Islands will continue to export precious and semi-precious woods, but cannot be depended upon to produce structural timber for export in quantity. The largest tracts of virgin forest remaining are found in Santo Domingo and the Island of Dominica.

In southern Mexico and along the west coast of that country nearly to Lower California are vast areas of tropical hardwoods of many kinds, including mahogany and Spanish cedar. The highlands contain extensive temperate forests of conifers and oaks. Mexico has more than enough timber for domestic needs, but will probably continue for many years to import as well as to export timber. A considerable proportion of Central America has been cleared or cut over, but there is still much timber available, the most valuable and sought for kinds at present being mahogany, cedar, and pine.

Colombia has accessible forests on the Pacific side and in the drainage

basins of the rivers flowing into the Caribbean Sea; the timber in the drainage basin of the Amazon is not now available. The best forests of Venezuela are in the lowlands at the head of Lake Maracaibo, the neighboring foothills of the Andes, parts of the coastal mountains, and the remoter parts of the Guiana Highlands. The Guianas as a whole are well timbered, and the British and Dutch colonies, especially, are advantageously situated for extensive development of their export trade.

Ecuador has accessible forests on the Pacific slope of the Andes, but the eastern timberlands are in the upper reaches of the Amazon. Peru and Bolivia have vast forest resources in the lowlands of the Amazon headwaters, but their extensive exploitation will probably be long deferred. A part of Paraguay is heavily forested and the best markets for the products are in Argentina, Uruguay, and southern Brazil. Southern Chile contains large quantities of Antarctic beeches and certain conifers, but these will be needed for the agricultural region which is rapidly being developed farther north; the northern part of the country is desert. Argentina has great areas of quebracho, but the stands of mixed hardwoods are limited, being best in Misiones; the slopes of the southern Andes in Patagonia are more or less heavily timbered with the same kinds of trees found in southern Chile, but access to the region is difficult. Uruguay is almost entirely dependent on outside sources for her lumber supply.

It is estimated that 40 per cent of the area of Brazil is still in virgin forest. The bulk of this is in the great Amazon basin in the north and most of this country has not been explored except along the water courses. There is also a valuable hardwood area along the east coast and there are Paraná pine forests in the south, but the best markets for these two regions are local or in neighboring South American countries.

From the foregoing it will appear that the forests which offer the best opportunities, from the standpoint of supplying the United States in the early future, are located in Mexico, Central America, northern South America, and the lower Amazon. Southern South America requires more timber than it can produce, while most of the timber stores of the upper Amazon will await the needs of the distant future.

WEST INDIAN ISLANDS

THE West Indian Islands comprise a great chain extending from the neighborhood of southern Florida eastward and southward toward the mainland of South America for a distance of 1800 miles. The most northerly group, the Bahamas, has always been considered as distinct from the others, collectively known as the Antilles. The latter are divisible into the Greater Antilles (Cuba, Jamaica, Haiti, and Porto Rico) and the Lesser Antilles (the Leeward and Windward Islands) which appear on the map as stepping stones between Porto Rico and Venezuela. Several islands off the Venezuelan coast resemble the mainland in formation and vegetation, but owing to their political separation are included as parts of the West Indies.

BAHAMA ISLANDS

THE Bahama Islands comprise 29 islands, 660 keys, and nearly 2400 rocks, aggregating about 4500 square miles. Most of the islands are low, but hilly and rocky. There are no fresh water streams, though there are fresh water marshes on some of the larger islands. According to Britton and Millspaugh,[1] "there are extensive forests of the Caribbean pine (*Pinus caribaea*), much reduced in recent years by lumbering, on the Great Bahama, Abaco, Andros and New Providence, and this tree occurs again on the Caicos Islands, but does not exist on any other islands of the Archipelago. On the larger islands, notably Andros, New Providence, and Great Bahama, and on some of the smaller ones, hardwood forests (coppices) occur, sometimes wholly enclosed by pinelands, like the similar 'hammocks' of southern Florida. These coppices are made up of a considerable variety of tall tree species. On most of the smaller islands, however, and in parts of the larger ones, the woody vegetation is wholly of shrubs and low trees, often of great density of growth, forming the 'scrub-lands.' Portions of these areas may have had larger trees upon them in the past, cut for lumber and firewood, but over great areas there is no evidence of large trees ever having existed. Locally some of these areas are known as 'low coppices.' The relationships of the native Bahamian flora are, as would be expected, with those of Florida, Cuba and Hispaniola."

1 BRITTON, N. L. and C. F. MILLSPAUGH: *The Bahama flora,* 1920, p. iv.

CUBA

Cuba has an area of about 45,000 square miles of which fully two-thirds has been cleared for agricultural purposes. The largest forest areas remaining are in the eastern provinces of Camaguey and Oriente, mostly on the poorly accessible slopes and ridges of the high mountains which terminate at Cape Maisi. The central provinces, Santa Clara, Matanzas, and Havana, are densely populated and produce large quantities of sugar, tobacco, pineapples, coffee, and other crops; the forests are confined mainly to the southern portion which includes Zapata swamp, a little known section densely wooded in part. In Pinar del Rio province, to the west, the forests, though rather extensive, have been depleted of the timbers for which there is a demand in foreign markets, namely, Spanish cedar, mahogany, and lignum-vitae. In fact, much of the accessible areas in Cuba which may be classed as forest lands have long since been stripped of their best merchantable timbers.

The Cuban flora, although distinctly tropical in character, occupies a geographical position in which the tropical and extra-tropical species meet and exhibits many points of relationship with southern Florida, a region with more than 200 kinds of trees which do not occur elsewhere within the continental United States. The pine, typical of the north temperate zone, grows side by side with distinctly tropical broad-leaf trees. Many exotic trees have become naturalized and are now an important factor of the second growth, especially on abandoned fields. The forests as a whole are characterized by the great variety of their tree growth, but the commercially valuable kinds are comparatively few and scattered among the many whose worth is yet to be realized. Selective logging methods are practiced and are much more expensive than would be the case if there were a good local demand for the inferior species. Clear-cutting, followed a few months later by burning, continues to be the common practice and, as only the choice logs are saved, the loss from such wasteful procedure is enormous.

There are more than 250 kinds of trees indigenous to Cuba, but scarcely a dozen of them are commercially important. The principal kinds of native timber in demand for local and foreign consumption are, in order of importance, mahogany, Spanish cedar, lignum-vitae, degame, lancewood, almique, "majagua," "jique," cocus or granadilla, and occasionally dyewoods. The value of the exports of wood, chiefly in log form, fluctuates between three-quarters of a million and a million and a half dollars annually. Mahogany and cedar comprise the bulk of the shipments and prior to the war these were mostly to European countries. As a natural consequence of Cuba's industrial development, the exportation of both mahogany and cedar will diminish; in fact the

demand for cigar-box wood in Havana has at times to be supplied in part by importations of cedar logs or box shooks from New York. Cuban lignum-vitae is considered the standard of the trade and available stocks will continue to be exported since there are almost no local uses of this timber.

The consumption of foreign lumber is on the increase and there are imported annually from the United States and Canada over half a billion board feet of pine, spruce, and fir lumber and large quantities of shingles, fruit crates, box shooks, heading and hoops, broom handles, and various other turned articles.

JAMAICA

Jamaica, largest of the British West Indies, has a total area of 4200 square miles, nearly all undulating or mountainous. This diversity in topography, and consequently in climate, is conducive to great variety of vegetation. Although sharp lines of demarcation are usually wanting, there are three fairly distinct zones, namely, the hot or littoral, the warm or rain forests on the slopes, and the cold or upper treeless areas. The coastal belt was originally covered with a dense tropical forest which has since been largely removed in the interest of agriculture; this portion of the island is densely populated. On foothills or well-drained areas there are various drought-resistant species, such as the West Indian birch, lignum-vitae, juniper, and Spanish cedar. There is, however, a noticeable intermingling of species in these two zones, as illustrated in the case of the juniper which grows from sea coast to an elevation of 5000 feet. Above the second zone the trees diminish in number and variety and the higher portions are in many places virtually treeless, except in the deep gullies or protected coves. The many small islands or "cays" (keys) along the coast are typical coral formations, fringed by dense mangrove swamps with an inner border of manchineel and sand-box.

The exploitation of the forests of Jamaica began with its earliest settlement and quantities of splendid cedar and mahogany logs were shipped, first to Spain and later to England and the United States. Conditions have gradually changed and only a fifth of the island, the least accessible portions, remains in forest. The woods now available for export are those for which there is little or no domestic use, such as lignum-vitae, lancewood, bitterwood, and pimento, but even these are not always obtainable at a price attractive to the trade. There are no roads outside of the densely populated sections and transportation is arduous and expensive. Moreover, there are no rivers that can be em-

ployed for floating logs from the interior to the seaports. In getting out lancewood, which grows in the gullies near the tops of the mountains, men carry the spars on their shoulders for many miles and it requires one or two days to get a single spar down the rough trail to market.

During 1916, when dyewoods increased so abnormally in price, Jamaica exported, chiefly to the United States, some 1400 tons of fustic and 75,000 tons of logwood. Since then the exports have materially lessened, partly because of the establishment of a dyewood-consuming plant on the island and also because the general demand for dyewoods has greatly decreased. Lignum-vitae is confined to the dry hot plains, principally on the south side of the island, and is of rather small dimensions; there is, however, a distinct demand for wood of this origin, both in the United States and Europe, and before the war about 500 tons were exported annually. The larger trees are rarely cut, because of the difficulty of transporting the logs to the shipping port, and the bulk of the sticks entering the American market are from three to eight inches in diameter and from a few to eight or ten feet in length. Satinwood, at one time an important article of export, now enters the market only in small lots; there is a moderate demand for logs measuring from six to nine inches in diameter, but they must be fresh and well grown, otherwise they can hardly be sold. Jamaica imports annually over a million dollars worth of lumber and manufactures of wood from the United States.

ISLAND OF HAITI

This island, variously known as Haiti (also spelled Haïti and Hayti), San Domingo or Santo Domingo, and Hispaniola, is second in size of the Greater Antilles and may be regarded as their geographical center. It exceeds the other islands of this group in altitude, diversity of topography, and irregularity of outline. It is about 400 miles long and 160 miles wide, and is divided politically into two unequal parts, the western third comprising the Republic of Haiti, the remainder the Dominican Republic. The political divisions are considered separately since the forests and forest industries are materially affected by the differences in the customs of the peoples of the two republics.

Republic of Haiti. The Republic of Haiti has an area of about 10,000 square miles. This includes the islands of La Gonave in the Gulf of Port au Prince, Les Cayemites just to the west, and La Tortue on the north coast, all of which have been the source of considerable quantities of wood for export. Judging from the topography of the country and the present character of the vegetation on the slopes and ridges of the hills, it appears that considerably less than half of Haiti was originally

Photo by C. D. Mell.

Unloading Logwood from Small Coasting Schooners in Haiti.

Photo by C. D. Mell.

Method of Transporting Lignum-vitae in Haiti.
(Pile of Logwood in Background.)

covered with merchantable forests. These upper slopes and ridges are sparsely timbered and the occasional clumps of pine trees would have little if any commercial value even if they could be made accessible. On the lower slopes and in the coves trees are present in greater variety and supply some timber for local uses and for export. Originally the forests in the valleys, for example, near Cape Haitien, Plaisance, along the Artibonite, Arcahaie, Port au Prince, Léogane, and Aux Cayes, were rich in valuable species such as mahogany, "bois chêne," and hog plum, but they have been cleared for agriculture. Such forests as now exist in these regions are composed for the most part of exotics and various kinds not a part of the original growth.

Haiti has a population of about 2,000,000 negroes, some 80 per cent of whom live in the rural districts, mostly crowded into the valleys. Because of this local density of population only fruit trees are permitted to grow in the agricultural regions. The mango, breadfruit, tamarind, genip, grapefruit, guava, bananas, and plantains contribute very largely to the food supply of the inhabitants. There are, to be sure, some large indigenous trees still standing, but they occur only scatteringly.

The local forests no longer meet the demand for construction material and from two to five million board feet of pine, spruce, and fir lumber are imported annually. During the early history of the mahogany industry logs of excellent quality and rich in color and figure were obtained in this region, but all of the large trees are gone. The timber now obtainable from isolated areas in the interior is too small and knotty to meet the requirements of the export trade and is used only locally. Spanish cedar is too scarce to be a factor in the foreign trade. "Bois chêne," called "roble" in Santo Domingo, is the most important tree in Haiti from the standpoint of lumber production for native needs and is highly esteemed for furniture and many other purposes. There are a number of other kinds such as "bois blanc," "bois fer," "bayahonda," and hog plum, some of which yield beautiful woods susceptible of high polish, but they are all small and unimportant. The "gommier" grows more or less abundantly on the lower slopes of the dry rocky hills, but no important use has as yet been found for its soft white wood, though it doubtless could be used to good advantage for making box shooks.

The only woods important for export are logwood and lignum-vitae. The logwood tree finds its most suitable environment in the interior valleys and in the moist coves on the lower mountain slopes throughout the country. The negroes fell the trees, which are rarely over 15 inches in diameter, and transport the short and irregular pieces on pack burros to the coast towns. Approximately 80,000 tons are exported

annually for making dyes, any other use being precluded by the small size and irregular, knotty, and fluted character of the stem and branches. There is a logwood extract plant at Grande Rivière in the Department of the North, but it consumes only a very small portion of the available material.

Lignum-vitae, known locally as "guaiac," "berra," or "vera," is a low and irregular tree, rarely 30 feet high and 20 inches in diameter. Between three and five thousand tons of logs in the rough are exported annually, most of them six to nine inches in diameter and from four to six feet in length. The largest and best timber is said to be on the Island of La Gonave, where it has not been exploited to the extent it has on the mainland. The islands of Les Cayemites and La Tortue have also supplied large quantities of lignum-vitae. There are eleven Haitian ports and all of them except Jacmel are actively engaged in the shipment of logwood and lignum-vitae.

Dominican Republic. The Dominican Republic, with an area of about 19,000 square miles, has much the same topography as that of Haiti, but apparently the country was more heavily timbered originally. There is far more timber available at present, due in considerable part to the fact that the population is less dense, there being only 35 inhabitants to the square mile as against 200 in Haiti. A large percentage of the fertile land has not yet been cleared for agriculture, except near the coast and along the streams, and much of the primeval forest remains undisturbed.

The soil of the region along the north coast and east of Monte Cristi as far as Puerto Plata, San Francisco de Macoris, and for many miles inland, is very arid and unproductive, except in the vicinity of the rivers, and over many square miles the only forests are along the lower slopes of the hills back from the coast, the most common trees being the "baitoa" and the "almacigo." Eastward and southward, around Samaná Bay and near La Vega and Santiago, is a region that formerly was rich in timber and, even though much of this section is now in cultivation, the best timber in the country for local use and for export is still to be found in the hills around Samana Bay. The future supply of Santo Domingo satinwood will be obtained in this part of the island.

Southward and westward along the coast to Barahona the soil is dry and has a low forest cover of no commercial value. The "bayahonda," or mesquite, forms the principal growth for miles, becoming less common along the streams and on the foothills where lignum-vitae, logwood, brazilette, and "almacigo" occur. In the interior, along the Central Cordillera where the soil is of decomposed coral rock which does not

retain moisture, the most characteristic trees are pine and juniper, though they are not in sufficient abundance to warrant the introduction of modern machinery for logging and milling.

Santo Domingo formerly supplied large quantities of mahogany, satinwood, lignum-vitae, and pencil cedar, but the best and most accessible timber has been cut. The total annual exports of woods at present are valued at less than $50,000, while the imports of pine, fir, and spruce are fully five times as much. There seems little basis for the often expressed belief in the great commercial possibilities of the remaining forest resources, if for no other reason than the excessive cost of transportation from the rugged interior. In the early days mahogany was one of the most important exports and it has always been considered the best for fine furniture, cabinet work, and rich interior trim. In recent years, however, the offerings of mahogany logs have been of inferior grade and they will continue to be so until better means of transportation are provided.

Lignum-vitae occurs throughout the country and, while nowhere very plentiful, supplies one of the chief forest products for the foreign trade, being shipped from practically every port. Around Barahona and Azua, in the southwestern part, the bulk of the wood is the "vera" or "berra," the so-called bastard lignum-vitae, and much of this goes to Europe either directly or via Curaçao or New York. To the eastward, especially around Santo Domingo City, the wood cutters bring in the so-called true lignum-vitae, locally known as "guayacan," in the form of small and rough logs two to four feet long and mostly under ten inches in diameter. Larger sizes are doubtless available, but are too heavy for the pack burros to carry over the rough trails. The total shipments vary from 300 to 1500 tons annually, depending upon the demand.

Satinwood, a valuable timber of commerce, is losing its importance; the principal source of the wood is the northeastern part of the country. Pine occurs in open stands on the upper slopes of the central hills and is too difficult of access to compete at present with the pine lumber from southern United States. Tanwoods and dyewoods have never been the basis of an important industry, because the natives are more interested in growing cocoa, coffee, sugar, and tobacco. The pods of the "divi-divi" are exported from the southern portions of the island, to the extent of about 1500 tons annually, for use as a tanning material.

PORTO RICO

Porto Rico, easternmost and smallest of the Greater Antilles, has a total area of only about 3600 square miles, including the small islands

of Vieques, Mona, and Culebra. Most of the surface was originally covered with a dense tropical jungle, interspersed with more or less extensive treeless areas, especially to the south of the central cordillera. While the general forest conditions were probably much the same as those of the island of Haiti, only 60 miles to the west, there is reason to believe that pine and probably the true mahogany were absent.

Following the Spanish settlement early in the sixteenth century much land was cleared and put into cultivation. The population rapidly increased during the several centuries of Spanish rule until it had reached an average of about 300 negroes and Spaniards per square mile in 1898, when the United States assumed control. Almost all of the land had passed into the hands of private owners and practically all of the forests, except in the Luquillo district in the eastern end of the island, had been cut down to make room for growing coffee, cocoa, cane, and tobacco, and also for pastures, since cattle raising was one of the chief industries. Forest conditions have not improved under the Americans, and indiscriminate cutting of wood for charcoal is resulting in the devastation of large areas which will not be cultivated.

Only about 20 per cent of Porto Rico is now wooded and only a fourth of this, chiefly in the Luquillo district, can be regarded as merchantable forest. Approximately 50 million board feet of lumber of all kinds are imported annually, in addition to such wooden products as shingles, box shooks, and crates. With further development of local industries there will be even less likelihood of the island supplying any timber for export, save, possibly, occasional small lots of satinwood, lignum-vitae and "tabanuco." Porto Rican satinwood was at one time considered the equal of that from Santo Domingo, except as to size. Lignum-vitae occurs on the south side of the island, chiefly on the dry calcareous soil, and the trees are short and small, rarely over eight inches through, and of the kind known in Haiti as "vera"[2] or "berra," though with thicker, rougher, and flakier bark. The "guaraguao," known as "cabimba" in Santo Domingo, is a beautiful red wood of excellent quality and is used very generally in Porto Rico in the manufacture of fine furniture. During the war some logs of it were shipped to New York, but there is too good a local demand to justify its export.

LEEWARD ISLANDS

The Lesser Antilles are divided geographically into two groups known as the Leeward and the Windward Islands because of their relative

[2] This is a species of *Guaiacum* and should not be confused with the "vera" of Venezuela, which is *Bulnesia arborea* Engl.

exposure to the northeast trade winds. The principal islands of the Leeward group, aggregating about 1700 square miles, are, beginning at the north, the Virgin Islands, St. Kitts, Antigua, Monserrat, Guadeloupe, Dominica, and Martinique; there are also numerous smaller islands. Part of the Virgin Islands belong to the United States; St. Eustatius, Saba, and a part of St. Martin are Dutch possessions; Guadeloupe, Martinique, St. Bartholomew, and a portion of St. Martin are French; the others are British.

Virgin Islands. The Virgin Islands, situated about 50 miles to the eastward of Porto Rico, form a connecting link between the Greater and the Lesser Antilles. Such forests as occurred along the small streams in a few of the valleys before the advent of white settlers have long since been cut down for local use, principally for charcoal. Along the shores are scattered clumps of mangroves, buttonwood, and manchineel, which in a few places give way to mesquite thickets. The most common tree, however, is the sand-box, but its wood is sparingly utilized. Yellow sanders was formerly rather plentiful and supplied material for furniture, but the timber is now very rare. Back from the coast the principal trees are such introduced kinds as the mango, alligator pear, sapodilla, cashew, mammee-apple, and soursop. Lignum-vitae, logwood, and brazilette occur on the upper and well-drained portions of the islands and, along with crotons and other shrubby plants, constitute the bulk of the vegetation on the interior elevations. Practically all the lumber consumed in the Virgin Islands is imported from the United States.

St. Kitts. This island is very mountainous, but the soil in the valleys and on the lower slopes is exceptionally fertile. The entire area was originally well timbered and mahogany logs of large dimensions and good quality were exported in the early days of the British occupation. Every accessible portion, however, has since been cleared for cultivation, so that the few remaining forests or wooded areas are confined to the upper slopes and are mostly inaccessible. The trees at lower elevations and in agricultural areas are chiefly exotics that have been planted or have escaped from cultivation and are afforded protection because of their fruit.

Antigua. Antigua, most important of the Leeward Islands, has a third of its area under cultivation. There are no mountains, such as characterize the other islands of the group, and the protracted droughts have retarded the growth of forests, though in the interior coves there are some xerophytic species such as the "tamarindo," logwood, lignum-

vitae, and brazilette. Logwood and the fruit of the tamarindo tree form articles of export. All of the lumber used on the island is imported from the United States and Canada.

Monserrat. Monserrat has an area of 32 square miles, fully two-thirds of which is mountainous, while the greater portion of the remainder is devoted to agriculture, chiefly the growing of limes. "Ceiba," "almacigo," "tamarindo," mango, palms, tree ferns, and other more or less important trees compose the forests at lower elevations, while the upper slopes and ridges are either bare of arborescent species or are covered with a croton type of vegetation. In locations having good soil and sufficient moisture are to be found the usual tropical trees common to the West Indies, but wherever the original forest cover has been interfered with by man, exotics are now in the majority.

Guadeloupe. Guadeloupe, the largest island of the Lesser Antilles, is divided by a narrow creek, the Riviere Salee, into two portions which differ as to formation, topography, and vegetation. The eastern, Grande Terre, is of limestone and in no part attains an elevation greater than 450 feet, while the other, Basse Terre, is almost wholly volcanic and mountainous.

There are practically no forests on Grande Terre, and the uncultivated portion, comprising about 60 per cent of the land surface, is covered with a low scrubby growth consisting chiefly of crotons and other xerophytic plants. On Basse Terre, forests occur on the upper slopes of the mountains and in the deep ravines. The high mountain ridge is almost continuously capped with clouds and, as a result of the considerable condensation, the slopes are clothed with dense vegetation wherever there is sufficient soil. The larger trees, however, are confined to the hardly accessible ravines, and the vegetation at higher altitudes is dwarfed and without commercial value. At lower elevations the important forest trees have all been cut and the present tree growth consists chiefly of naturalized species, such as the mango, "tamarindo," "cha-cha" or chatterbox tree (*Albizzia Lebbek* Benth.), and various others introduced for their fruit. In the early days of the French occupation, occasional lots of mahogany logs and dyewoods were listed among the exports, but now only small quantities of lignum-vitae, satinwood, and brazilette are obtainable. The local consumption of native grown timber is limited almost entirely to fuel wood.

Dominica. Dominica, the largest of the British Leeward Islands, has a total area of 290 square miles, and is very rough, especially in the interior. The mountains are entirely forested to an elevation of 3500

feet, above which is the dwarf vegetation so common at lower elevations on the other islands northward. The forest is better on the leeward side of the island, where the heat is greater and the rainfall less than on the windward. The deep ravines and sheltered valleys on both sides of the central ridge exhibit virgin forests, in which are considerable quantities of cedar, "gommier," "caripete," "bois diable," West Indian locust, yellow sanders, mastic, bully tree, "pui," "galba," rosewood (*Cordia Gerascanthus* L.), and various other important species. These timbers are used to some extent locally, but not for export, because of their inaccessibility, a condition which will eventually be remedied.

Cocoa, sugar, coffee, and other tropical products are raised under more intensive management in Dominica than on any other island of the Lesser Antilles. Within the agricultural settlements the forests have, of course, been greatly modified and the native species have given way to exotics, such as the "caimite," sapodillo, mammee-apple, breadfruit, cashew, Indian almond, and tamarind.

Martinique. About a third of Martinique's total land area of 380 square miles may be classified as plains, while the remainder is extremely hilly and rough. There is plenty of rainfall and abundant soil on the slopes of these hills, so that forest growth is more luxuriant than on the others of the Leeward Islands farther north. While a few of the ridges are treeless on the windward side, the slopes and lower ridges are so thoroughly clothed with forests as to conceal the general ruggedness of the country. The population consists of nearly 200,000 negroes, chiefly engaged in agricultural pursuits on the lower plains and fertile valleys. On first thought it may seem strange that not more of the forests have been devastated, but the lack of roads and the ruggedness of the country have made logging difficult, while the numerous rains and moist forest floor afford effectual protection from fire. Notwithstanding the fact that Martinique has approximately half its land surface covered with forests, of which a good part yields merchantable logs of valuable timber, there is imported annually from the United States fully half a million dollars worth of lumber and manufactures of wood of all kinds.

WINDWARD ISLANDS

The Windward Islands, with an aggregate area of about 510 square miles, include St. Lucia, St. Vincent, Grenada, and a chain of smaller islands, called the Grenadines, lying between St. Vincent and Grenada. They are all British possessions. Barbados, although fully 100 miles distant, is generally regarded as a member of this group.

St. Lucia. More than half of St. Lucia's land surface of 233 square miles is still forested. The slopes and uncleared interior valleys are clothed with the original forests which constitute one of the island's chief natural resources. The great fertility of the soil, coupled with abundant rainfall throughout the year, bring about optimum conditions for forest development, and here, as in Dominica, are valuable timbers of much local utility which are more or less well known in the foreign markets, especially Liverpool and London. Logging, however, is not a regular occupation of the people, since they prefer the field to the forest and the edge of the forest to its interior. Charcoal and fuel wood are obtained chiefly from land that is being cleared for agriculture purposes and are exported in considerable quantity to Barbados. On abandoned areas and on the lower slopes of the windward side of the island, logwood is cut during the period of the year when other work is slack and is shipped to England and France. Mahogany and cedar logs find a ready market in England, but they are not abundant. The exportation of any particular kind of timber has been small, because the trees are scattered and logs cannot be gotten out economically and in sufficient quantity to render the enterprise profitable. While there is a local demand for native-grown timbers, the requirements are chiefly for wood light in weight and easily worked and, consequently, upward of half a million feet of pine, spruce, and fir is imported annually from the United States and Canada.

St. Vincent. St. Vincent, with an area of 150 square miles, is very mountainous and all the slopes up to 2000 feet are covered with forests. The volcanic eruption of 1902 devastated large areas of timberland which have since grown up with the trumpet tree and other forest weeds, in place of the usual tropical West Indian species forming the bulk of the forests in the fertile interior valleys. In the cultivated sections the native trees have given way almost entirely to introduced kinds. Captain Bligh, of Bounty Mutiny fame, introduced the breadfruit tree from Tahiti in 1793 and it now forms an important part of the arborescent vegetation in all inhabited parts. Many valuable fruit and ornamental trees from the Far East have been planted and there is hardly a place in the West Indies whose early history is more interwoven with the introduction of tropical horticultural trees than St. Vincent. The first cloves came from Martinique in 1787, and the first nutmegs from Cayenne in 1809, and all have flourished.

Grenada and the Grenadines. Grenada has an area of 130 square miles, of which nearly two-fifths is under cultivation. The interior is very mountainous, there being a central north-and-south range, with numer-

Photo by L. H. Bailey.

Turner's Hall Wood, Barbados.

Photo by C. S. Rogers.

A Forest Scene in Trinidad.

PLATE II

ous irregular side spurs and well-watered fertile valleys between them. The precipitation is about 100 inches a year, but the run-off is retarded by the vine-clad cliffs and densely wooded hills. There are areas of virgin timber among these hills, and considerable quantities of firewood are shipped to Barbados and small quantities of logwood and fustic to England. The amount of lumber shipped into Grenada is negligible, as logs of Spanish cedar, mahogany, "cip wood," and "roble" are pit-sawn in sufficient quantities to meet the local needs.

Barbados. Barbados, easternmost of the Caribbean islands, may properly be included in the Windward group. Within its total area of 166 square miles there are approximately 200,000 inhabitants, or about 1200 to the square mile. As a result of this heavy population, the densest in the West Indies, practically all of the original forests have long since been depleted or greatly modified by human agencies. The species represented in the few small natural groves, presumably the remnants of the virgin forest, indicate that the original forest flora was much the same as on the rest of the Lesser Antilles, and there are good reasons for believing that the first settlers found the entire island covered with a dense growth of cedar, mahogany, "santa maría," sea grape, juniper, quassia, hog plum, sand-box, West Indian birch, white-wood, bully wood, manchineel, satinwood, lignum-vitae, and other tropical species. These settlers were not long in discovering that the soil was well adapted to the growth of sugar cane and practically the whole of the island was soon cleared to make room for what is now the main industry. The absence of timber has proved a very serious hindrance to industrial development, and today Barbados is obliged to import annually from the islands of the Lesser Antilles, Demerara, and other parts of the mainland, about 12,000 cords of fuel wood, the greater part of which is consumed on the plantations as fuel in steam engines. The annual imports of lumber of all kinds, chiefly from the United States, amount to more than one-half million dollars.

TRINIDAD AND TOBAGO

The flora of Trinidad and Tobago differs so little from that of the mainland that the two islands might very well be considered in connection with Venezuela, were it not for the fact that politically they constitute a Crown Colony of the British West Indies. Trinidad, with a total area of about 1750 square miles, is separated from Venezuela by the Gulf of Paria and the narrow channel known as Boca Grande or Dragon's Mouth. The population of approximately 300,000, or about 150 to the square mile, is engaged primarily in agricultural pursuits.

During the time of slavery, the chief staples were sugar, cotton, and indigo, but since 1846 these have largely given way to cocoa, rubber, coconuts, and limes. Because of the indiscriminate clearing throughout the island, a system of efficient forest protection and reforestation was found necessary. It had become a practice to allow cleared areas to revert to forest after a few crops had been grown under an extensive system of management, and this resulted in a serious scarcity of timber in the populous localities. There is now a well-defined colonial forest policy which provides both for the establishment of plantations and the conservation of the natural forests. There are at present about 338 square miles in forest preserves, but they consist largely of areas that previously had been wholly or partially denuded and, consequently, only a small percentage of the trees now standing are merchantable. Among the trees which have been planted, or may be recommended for planting later, the most important are Spanish cedar, mahogany, "pui," teak, rubber, "cyp," eucalyptus, and Australian pine (*Casuarina*).

Originally the greater part of the island was covered with dense forests of useful species. There are, however, as in most tropical countries, extensive grassy areas, or savannas, not only on the plains, but also on the upper slopes of the hills and mountains. Outside of these treeless areas are luxurious virgin forests, especially in the northeastern part, because of the heavy precipitation from the constant moisture-laden trade winds which impinge on the mountain range of the north, where a few of the peaks reach nearly 3000 feet elevation. The several high ridges, with an easterly and westerly trend, have fertile valleys between them that are well watered and drained by large streams, with numerous tributaries rising in the deep ravines and gorges. On the whole, the island is comparatively level and is well suited for all kinds of tropical agricultural crops, as well as for forestry purposes.

Approximately one-fourth of the land surface is under cultivation, the remainder consisting of forested or partially forested areas, swamps, and savannas. Spanish cedar has always been the most important timber tree and grows to larger size than elsewhere in the West Indies. Before the war, Trinidad enjoyed a considerable export trade in cedar, which went chiefly to Hamburg; during the war small quantities were shipped to the United States. On account of the demand for export, as well as for local use, nearly all of the best cedar trees have been culled out of the forest and the quantity that is still available for export is relatively small. In 1922, there were in the government plantations approximately 150,000 young cedar trees, each estimated to yield from 90 to 120 cubic feet of wood at the age of 60 years. Other woods in common use for general construction and carpentry are "mora," crabwood, purpleheart,

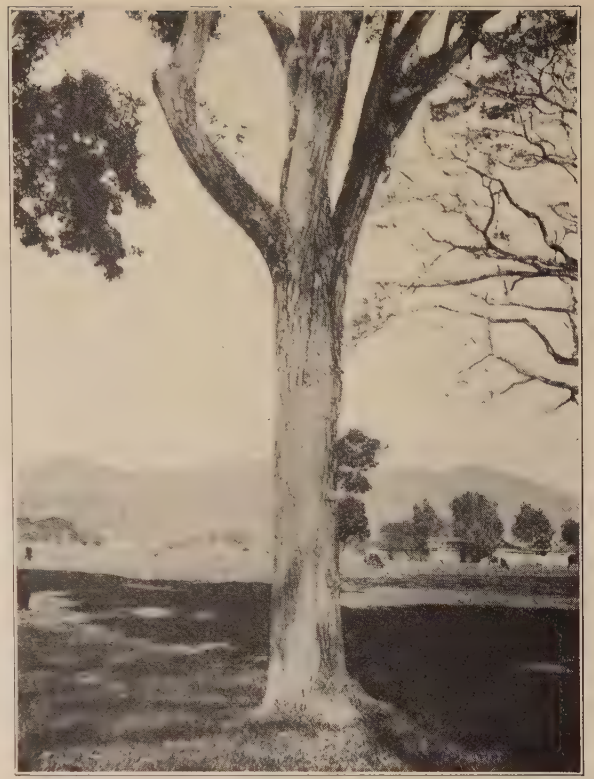


Photo by C. D. Mell.

Pui Tree in Trinidad.

Photo by C. D. Mell.

A 19-year Old Mahogany Plantation in Trinidad.

PLATE III

"pui," locust, "balata" or bullet wood, "cyp," "roble," and balsam. Crabwood and mora are occasionally shipped to England, but there is no regular demand for them. There is also a limited trade in fustic. Lumbering operations are very primitive, and local woods are at a disadvantage in competition with those from the United States, because of their tendency to warp and split when exposed to the weather, as well as on account of the difficulty of getting proper dimensions for building purposes. The annual imports of lumber and manufactures of wood from the United States are valued at about one million dollars.

Tobago is in many respects not unlike Trinidad. It is rather hilly at the north end, where the highest point is about 1900 feet above sea level, but gradually becomes lower toward the south, so that nearly one-third of the island is fairly level. The soil is even more fertile than that of Trinidad. Fully five-sevenths of the land is privately owned, about 7000 acres are set aside as a forest preserve, and the remainder is the so-called Crown Land. Fully half of the island is covered with forests which still retain their finest trees, because there has been no attempt made to export timber from this island and the local demands are not heavy. The population, consisting chiefly of negroes, averages about 150 to the square mile, practically all employed on large estates in raising crops similar to those in Trinidad.

DUTCH WEST INDIES

The Dutch West Indian possessions are not extensive and consist of a few small islands lying just north of St. Kitts, namely, Saba (five square miles in area), St. Eustatius (about seven square miles), and a portion of St. Martin (17 square miles), while off the Venezuelan coast are Oruba (Aruba), Curaçao, and Bonaire (Buen Ayre). Oruba is about 70 square miles in extent and the population of about 1000 is mostly engaged in agriculture. The island is more or less rugged, though nowhere high, and its vegetation is very sparce. Brazilette is cut occasionally, but "divi-divi" and aloes constitute the chief articles of export. Bonaire's 95 square miles supports a population of 6000 and the conditions are much the same as on Oruba. The bulk of the Dutch West Indian "divi-divi" is produced on this island and there is also a fairly good growth of brazilette and aloes.

Curaçao has an area of about 200 square miles and a population of approximately 30,000. Shipping is the chief industry. The surface of the island is undulating, although nowhere over a thousand feet above the sea, and agriculture is limited to the few fertile glens at the foot of the hills. Vegetation is very scant and consists of "divi-divi," brazilette,

mesquite, and various other xerophytic kinds. The island is important in the timber trade, however, because considerable quantities of woods emanating from Dominican ports and from Maracaibo and Curapano, Venezuela, are entered for transshipment to the United States and Europe. The principal woods so transshipped are boxwood, "guayacan," cedar, brown ebony or partridge, and fustic from Maracaibo; "vera" from Curapano; and "vera," ebony, "almacigo" boards, logwood, brazilette, mahogany, cedar, lancewood spars, fustic, lignum-vitae, partridge, and "roble" from Santo Domingo.

MEXICO AND CENTRAL AMERICA

This portion of the North American continent has an area of about 977,000 square miles. The seven Spanish-American Republics and one British Colony are political divisions unrelated to natural phytogeographic areas and their boundaries do not coincide with limits of vegetation. The northern frontier merges imperceptably into the southwestern United States, while southward the continuity of species is nowhere sharply broken. There is, to be sure, a noticeable change when Panama is reached, but the transition to the South American continent is not abrupt.

The general topography of the region has much in common, there being an elevated interior, wide at the north and constricted and occasionally interrupted toward the south, flanked on both sides by coastal plains of variable width. On the uplands are familiar trees, both conifers and hardwoods, of the north temperate zone, giving way at lower elevations and in the south to tropical hardwoods such as characterize the whole Caribbean region. From a timber standpoint, the country is best known as a source of mahogany, Spanish cedar, and other cabinet and special woods, but there are vast quantities of timbers of another class which are beginning to assume some importance in the foreign trade. The advantage of geographical position, particularly with reference to the markets of the United States, are unequalled by any other tropical American region exclusive of the West Indies.

MEXICO

"Mexico has an area of 767,000 square miles, which, although only about one-fifth that of the United States, exhibits a greater range of climatic conditions. The extremes of elevation much exceed those of the

Photo by H. M. Curran.

Along the Coast of Curaçao.

Photo by H. C. Kluge.

Scrub Oak on Semi-arid Hills of Tehuantepec, Mexico.

United States, ranging from sea level to over 5200 meters. Almost every conceivable plant formation is represented—the wet tropical forests of the southern lowlands, the temperate deciduous and coniferous forests of the central plateau and of the ranges of the Sierra Madre, the alpine zones of the high peaks like Orizaba, Popocatepetl, and Ixtaccihuatl, and the great barren or cactus deserts which reach their best development in the northern states."[3]

The Mexican plateau between the high marginal sierras extends for over a thousand miles southward from the Rio Grande. It is about 250 miles wide and 3500 feet high in the north but gradually becomes narrower and increases in altitude to about 8000 feet near the City of Mexico where its southern extremity is marked by numerous peaks, some of them over 17,000 feet above the sea. To the south and east of Mexico City and within the states of Vera Cruz, Tabasco, Oaxaca, and Chiapas, the interior country is greatly diversified. There the immense chains of the sierras converge, forming a low tableland with many rugged gorges and beautiful fertile valleys. The portion of Mexico lying between the 16th and 18th degrees of north latitude constitutes the famous Isthmus of Tehuantepec. At its narrowest part the continuity of the high cordilleras is broken by a sudden depression where the surface slopes to either shore from an average summit level between 600 and 800 feet, reaching the Pacific in 28 miles and the Gulf in 110 miles. The last 75 miles of the decline to the Gulf shows an average descent of scarcely a foot to the mile.

The great northern states of Coahuila, Chihuahua, Sonora, Durango, San Luis Potosi, and Baja California, support a typical desert flora similar to that of western Texas and southern New Mexico and Arizona. The tops of the highest mountains are practically bare of tree growth, and not a few of the lofty peaks are perpetually covered with ice and snow. On the tablelands, which are mostly from 5000 to 8000 feet above sea level, the aridity is equal to that of the driest desert, and there is no true forest growth except for occasional open coniferous stands forming narrow belts along the slopes. Yellow pine, scrubby lodgepole pine, and, less commonly, Engelmann spruce and Douglas fir, constitute the bulk of the trees in these forests. Notwithstanding the fact that there is very little rainfall on the plateau, streams do gather volume there and, in their downward courses over the successive benches, carve out huge ravines (barrancos) through which the clouds roll upward from the plains below. The heavy precipitation at high elevations gives rise to intermittent streams sparsely fringed with vegetation, while lower

[3] Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.*, 23: 1: 1, Oct. 11, 1920.

down, where the stream beds do not run dry, true forests form the connecting link between the upper treeless region and the densely wooded coastal plains. The latter constitute the great tropical timber wealth of Mexico.

The Atlantic coastal plain is from 40 to 50 miles wide at the north, but widens out considerably to the south and east. Through it the drainage from the interior slopes of the sierras discharges into the Gulf, leaving extensive alluvial deposits of great fertility. The coast line is comparatively regular throughout its total length, exclusive of the indentations, of about 1400 miles along the Gulf and 330 miles along the Caribbean Sea. The vegetation exhibits close affinities to that of the West Indies and many of the species are the same. The Pacific coastal plain is narrower and is remarkable for its irregularity. It slopes gently to the abrupt base of the sierras, though broken occasionally by prominent spurs from the interior plateau. This narrow strip extends along the coast from Guatemala northward 2500 miles to the mouth of the Colorado River. The Peninsula of Lower California, or Baja California, is nearly 800 miles long and has a coast line of 2000 miles, thus making the total Pacific coast line of Mexico about 4500 miles.

These torrid coastal plains, generally known as "tierras calientas," are exceedingly rich in the variety of their vegetation. In passing from the Gulf coast to the interior, one encounters trees of various zones and climates; at an altitude of from 3000 to 4000 feet the forests begin to assume the characteristics of those of the temperate zone; still higher up oaks, pines, cedars, and firs mark the complete transition from the hot to the cold climate, until at last scrubby forms are lost at the snow line nearly 11,000 feet above the sea. The same general conditions prevail on the Pacific slope, except that the species of important timber trees differ materially.

REGIONAL FOREST DESCRIPTIONS

That portion of the Atlantic coastal plain north of the Soto de la Marina River, a navigable stream in Tamaulipas, is within the temperate zone and exhibits a flora similar to that of southern Texas. The lowlands, which are from five to seven miles wide, are sandy, unproductive and, for the greater part, uninhabited, except in the extreme northern part. Immediately to the west are the foothills clothed with scrubby oaks, mesquite, walnut, persimmon, and various other trees of poor timber form and relatively low economic value. Walnut, Mexican ash, and red gum are confined to the moist and fertile valleys and lower slopes which have not yet been cleared for agriculture. Toward the interior and at still higher elevations where rainfall is sufficient for tree growth

Photo by H. C. Kluge.

In the Chicle Forest, Tehuantepec, Mexico.

Photo by C. C. Mengel & Co.

Logging Mahogany in Quintana Roo, Mexico.

there are coniferous forests of varying density and importance, although these elevated regions are usually so rugged that the timber is, for the most part, inaccessible. The predominating species are Emory oak and piñon pine. In localities where the conditions are more favorable, extensive forests of Chihuahua pine and Douglas fir are common.

To the south of Soto de la Marina River, Tamaulipas is very mountainous practically to the shore, thus carrying the temperate vegetation well into the tropics. From Tampico, the capital, situated near the mouth of the Panuco River, southward to the Laguna de Terminos, is an unbroken belt of purely tropical forest varying in width from 40 to 100 miles, being widest in Tabasco. The littoral forest is composed chiefly of the black and the white mangroves and is bordered by a luxuriant growth including the sea grape, hog plum, blue mahoe, logwood, and various other strand trees. On the more recent alluvial deposits, as on the deltas of rivers in Tabasco, is a characteristic formation of mixed hardwoods and royal palm, while in the inhabited parts are numerous exotics, such as the mango, tamarind, and almond, which have escaped from cultivation.

At an elevation of 200 feet the forest flora assumes a somewhat different aspect, due to the entrance of more important timber trees. One species of mahogany (*Swietenia humilis* Zucc.) finds conditions more congenial farther inland and on the lower slopes of the mountains up to an altitude of 2000 feet, extending as far south as the Isthmus of Tehuantepec where it crosses the Continental Divide to the Pacific side. The Mexican or large-leaved mahogany (*Swietenia macrophylla* King) is confined to the coastal lowlands and inland along the rivers from Vera Cruz to Guatemala and southward. Cedar occurs with the mahogany and is found on both west and east slopes up to 3000 feet elevation.

Although no systematic reconnaissance has ever been made of the Mexican forests and little has been published relative to the composition of the vegetation of the coastal belt, the principal commercial hardwoods are well known. The timbers available in quantities for local use as well as for export are mahogany, cedar, "prima vera," "sapota," yellow guayacan, fustic, logwood, brazilette, and "ceiba." Merchants in Tampico, Tuxpam, Vera Cruz, Minatitlan, and Frontera are offering these timbers, which are found in abundance along the coast and in a zone ranging from sea level to an altitude of 3000 feet. Walnut and red gum occur on the moist slopes, the gum often growing in nearly pure stands.

In the zone immediately above the 3000-foot limit the forest assumes a somewhat different aspect. The individual trees are of a temperate rather than a tropical type, but, being in the humid region, the forest retains its tropical density with the characteristic growth of lianas

(twining and climbing plants) and is far more complex in its composition than the hardwood forests within the temperate zone. Just above are the deciduous forests in which the sycamores, oaks, red gum, and alder form an important part. With the increase in altitude, the pure hardwood forests give way to stands of pines, firs, and junipers, of varying density and importance, with a mixture of deciduous oaks, alder, and myrtles. Near the timber line, about 10,500 feet, are low juniper bushes and a stunted and much contorted pine (*Pinus Hartwegii* Lindl.).

The Yucatan Peninsula includes the Mexican states of Campeche, Yucatan, and Quintana Roo, the whole of British Honduras, and a part of Spanish Honduras. The Mexican portion of this peninsula has a coast line of 700 miles, of which about half lies along the Caribbean Sea, and an area of about 55,000 square miles. It is nowhere above 900 feet elevation and is for the most part excessively dry; consequently the forests are poorly developed and in decided contrast to those in Tabasco and in parts of Vera Cruz.

The region all along the Gulf of Mexico and the Caribbean Sea for a distance of from 40 to 60 miles inland is low, level, and generally wet, and is covered with a primeval forest seldom traversed by white men. Along the outer margin is an impenetrable mangrove swamp from one to ten miles wide, back of which is a strip of country with very poor soil and suffering during a part of the year from excessive dryness. The forests contain many species of *Acacia*, and along the north or Gulf coast logwood forms a very conspicuous part of the stunted growth. No gigantic trees tower above the general level of the forest cover. The tallest is the chicle, but the most conspicuous is the swollen and buttressed "ceiba" or silk-cotton tree. One of the most important trees is the "ramón" or "ox" (*Brosimum alicastrum* Swartz), its leaves serving as fodder for cattle during the dry season and its timber for carpentry work. Lignum-vitae is very common in the dry soil, especially near Tislam, east of Progreso, and all along the Gulf coast. The "pom" (*Protium heptaphyllum* March.) is an important tree producing a gum-resin which the ancient Mayans used for incense in their temples.

In the coastal region to the south of Cape Catoche, the most northeasterly projection of the peninsula, the forests attain a somewhat greater development, especially along the western side of Chetumal Peninsula and surrounding Chetumal Bay. The Hondo River, which forms the boundary line between Yucatan and British Honduras, has for many years been noted for the facilities it affords for rafting mahogany logs from the interior to the shipping port. During recent years the southern part of Quintana Roo has played a prominent part in

supplying mahogany, cedar, and logwood. The chicle tree is abundant all along the east coast where the forests are worked by the Indian "chicleros" for the gum. The interior of the country is undulating and presents an entirely different aspect from that of the coast line with its low and dense growth. At one time it was fairly well wooded, except on the limestone bluffs and the grassy savannas to the south of the Gulf of Carmen, but the forests have suffered considerable modification through human agencies. Vast stretches have been cleared for sisal plantations and other farm crops. Fully 90 per cent of the 300,000 people in the Peninsula of Yucatan live in the State of Yucatan, which occupies the dry interior where sisal-growing forms the chief industry.

The southern sierras, which are from 500 to 900 feet high, are as dry as the northern plains of the peninsula, and the vegetation generally suffers from the arid condition of the soil, due to the fact that the water from the occasional heavy rains drains off rapidly through the porous surface limestone. The hills in the interior of the State of Yucatan are not so densely wooded as they are farther to the south and west where rains are more frequent. The southern sierras, or Sierra Alta, are mere limestone bluffs or ridges, often lustrous white in the sun and tufted here and there with clumps of dwarf trees. Campeche, the most westerly of the political divisions of the peninsula, as already described, is well wooded along the coast; logwood forming the principal growth, especially in regions inundated for a part of the year. The City of Campeche is the chief logwood center in the Republic. Farther inland from the Gulf of Carmen and extending entirely around and along the Gulf into the State of Vera Cruz, is an extensive, low, grassy savanna sparsely dotted with small tracts of woodland. Beyond this is the region drained by the Candelaria River, in which the true tropical hardwood forests occur. In the hinterlands of Campeche and a part of Yucatan, between the towns of Halapun of the one and Bakalan of the other, is a region of dense forests with large mahogany, cedar, chicle, and "ceiba" trees. These forests extend southward and westward into the State of Peten in Guatemala and into Tabasco, where the bulk of the Mexican mahogany is now obtained and floated down the Usumacinta River to its mouth. Much of this timber is rafted to the port of Carmen, which is the principal port also for the State of Tabasco. While mahogany forms the principal export of Campeche, the bulk of the wood is derived from regions beyond its boundary lines in Tabasco and in Peten, Guatemala.

The greater part of Tabasco is very sparsely inhabited and contains extensive forests. The littoral flora presents much the same conditions as in Vera Cruz and Campeche. The white and the black mangroves,

hog plum, sea grape, and blue mahoe are the predominating trees, though somewhat farther inland and away from the brackish soil are large forests of pimento and calabash trees. Numerous bays and mouths of small and large rivers render the shore line very irregular and give rise to great areas of swamp land. The two principal rivers, the Usumacinta and the Grijalva, unite near Frontera. The Usumacinta rises far in the interior of Guatemala and Chiapas where its upper course, called Chixoy, forms the boundary line between Guatemala and Chiapas. It is one of the most meandering rivers in Mexico and is said to be navigable for large steamers for a distance of about 180 miles or nearly half of its total length. The Grijalva, which is almost as large, drains the northern and central parts of Chiapas. During the rainy season, from March to May, these rivers overflow and in many parts give rise to permanent swamps and extensive regions of grass land. Immediately along the river banks are such forms of vegetation as can endure periodic submergence, such as willows, cecropias, palms, and various thorny shrubs and trees. Some distance back from the banks, where the surface is not inundated, cocoa and logwood plantations have been established. From the termination of the flat lands up to an elevation of 4000 feet are the virgin evergreen forests consisting of a mixture of oaks, alders, walnut, myrtles, magnolias, red gum, and cedar. In the vicinity of Triunfo in Chiapas are the true rain forests which are in striking contrast to those in the elevated region of Vera Cruz where the trees of the same species are deciduous.

Chiapas is rather densely populated and, as the soil in the valleys and on the lower slopes is very fertile, considerable areas once densely forested have been cleared[4] for the cultivation of coffee, cocoa, cotton, corn, and other crops. The central portion of the state is an elevated plateau extending into Guatemala. At the higher elevations are pine forests with a mixture of oak, the proportion of which increases as one descends toward the 3000-foot level. Below this are logwood and brazilette which are cut in considerable quantities and transported in rafts to shipping ports. Cedar attains its best development in Chiapas and is an important article of export.

The Isthmus of Tehuantepec, comprising the southern and eastern parts of the States of Vera Cruz and Oaxaca, is noted for the richness of its vegetation. The interior tableland, with an area of about 1400 square miles, is covered with dense forests abounding in massive trees of great variety, including the "espavé," "prima vera," "conacaste,"

[4] Much damage is done to the forests of southern Mexico by nomadic Indians who destroy the timber to make room for growing corn, but soon abandon the clearings for new ones. Because of this habit they are known as "flacoleros."

Photo by C. C. Mengel & Co.

Building a Logging Railroad in Mexico.

Photo by H. C. Kluge.

Santa María Trees in Tehuantepec, Mexico.

PLATE VI

"santa maría," and West Indian locust, while in isolated localities are oaks and pines. Rubber trees (*Castilla*) reach their best development on the Pacific slopes of the continental divide, while the chicle trees find their most congenial environment on the Atlantic side. At the headwaters of all the streams draining the northern slope of the interior mountainous area of the isthmus are huge specimens of the usual tropical tree species found growing from the Gulf shore to an altitude of 3000 feet. Hardwoods and, to a lesser degree, coniferous trees are mingled with numerous varieties of palms, vines, and spiny shrubs into an almost impenetrable jungle along the rivers, but farther back the forests become less dense and are composed of trees of greater commercial value, such as mahogany, cedar, chicle, logwood, brazilette, and fustic. Some of the finest mahogany logs are derived from this region. The abrupt depression in the sierras at the Isthmus of Tehuantepec made it possible for many of the typically Atlantic species to cross over to the Pacific side.

The forests of the Peninsula of Lower California (Baja California) and of the narrow coastal plain as far south as the Tropic of Cancer are similar to those of southern California and are not of economic value, though favored locations on the slopes of the sierras toward the interior are, of course, covered with oaks and coniferous forests of varying density and importance. The coastal region extending from a point opposite the southern extremity of Lower California to Guatemala exhibits little variation in its forest flora throughout its entire length. The vegetation has a more or less well-defined season of growth and the trees are chiefly deciduous. The lowland plain varies in width from 20 to 40 miles and is indented by many mangrove-fringed salt water lagoons. Immediately back of this littoral formation the brazilette, lignum-vitae, mesquite, oaks, and various leguminous species occur, all of which are able to withstand the alternate wet and dry seasons. Although this sandy plain becomes exceedingly dry during a part of the year, much of the area is under cultivation and the original forests have largely been destroyed or at least decidedly modified. Many of the original species have disappeared and exotic fruit trees have replaced them in the densely populated areas. In the fertile valleys in the foothills and in the deep moist ravines the vegetation often assumes a distinctly tropical appearance and in part takes on the character of true rain forests with the majority of the trees evergreen. This is noticeable particularly in the States of Guerrero, Oaxaca, and Chiapas, where large and important timber trees such as the "conacaste," walnut, locust, "prima vera," cedar, and mahogany, attain their best development. In this zone are many evergreen oaks, but at higher altitudes they

gradually give way to deciduous oaks and to pines, fir, and spruce. Toward the north are large areas of pine timber, while in the State of Colima the oaks find optimum conditions for their development. Above 6000 feet elevation the oaks often become stunted and the forests are composed largely of Douglas fir, western yellow pine, piñon pine, and Engelmann spruce, while at still higher elevations, and especially on the ridges of the sierras, the region has a barren and desolate appearance with extensive areas of bare rock forming a striking feature of the landscape.

THE GENERAL SITUATION

It has been roughly estimated that there are between 20 and 25 million acres of densely wooded areas in Mexico. How much of the coniferous forests are included in this cannot be stated, but a large percentage of the growth of pine, spruce, and fir in the States of Chihuahua, Durango, Jalisco, Michoacan, and Guerrero cannot be classified as dense forests. While the best stumpage of coniferous woods doubtless occurs in these states, the average lumber yield per acre would scarcely exceed a thousand board feet. As has already been outlined, most of the coniferous forests are in comparatively inaccessible regions and will not be exploited until better means of transportation can be established. Meanwhile Mexico relies in large measure upon the United States for much of the sawn lumber used in general building and construction work.

While the area of hardwood forests in Mexico is not far in excess of that of the conifers, the quantity of standing hardwood timber is considerably greater. Moreover, since the merchantable hardwood forests are confined to the lowlands and lower slopes of the sierras, they are, on the whole, more readily accessible. The principal railroads, as well as the navigable rivers and the bulk of the population, are within the area of agricultural lands embraced by the hardwood type. These conditions are largely responsible for the fact that hardwood timbers of Mexico are being exploited more extensively than the conifers, not only for a wide range of local uses but also for export. The best known timbers are mahogany, Spanish cedar, logwood, fustic, brazil, walnut, "prima vera," "conacaste," oaks, "granadillo," mesquite, and lignum-vitae. Besides these there are many other kinds which sooner or later will doubtless find favor among the wood-users of the United States and Europe.

BRITISH HONDURAS

British Honduras, a British Crown Colony sometimes called Belize, occupies a part of the Peninsula of Yucatan, and is about 160 miles

long, 50 miles wide and extends along the Caribbean Sea. It has an area of about 8600 square miles and a population of approximately 45,000. The country is well watered by at least sixteen rivers, but only the Honda and Belize are suitable for mahogany operations. The coast is low, differing little from that of Yucatan, but soon gives way to the Mantee Hills 800 to 1000 feet high, beyond which are the Cockscomb Mountains with elevations up to 4000 feet. Fringing the coast and coastal lagoons is a strip of mangrove. Immediately back of this is the so-called "pine ridge" country which resembles the pine flats of southern Florida. In the flat country north of Belize River the pine area extends deeply inland; there is also a large area of park-like pine land with excellent grazing on a high plateau close to the Guatemala boundary. It is estimated that fully a third of the area of British Honduras is occupied by pine ridge country, mostly open and park-like with occasional mixtures of oaks, low palms, and wild plum trees. The pine is of fair size and quality and will eventually become of considerable commercial importance. In some places, as in the region of Roaring Creek, there is a comparatively high percentage of oak and some of the trees are large and free of branches for fifty feet.

"Cohune ridge" is an inappropriate name applied to rich, low-lying strips generally along the streams where the cohune palm comprises about a fourth of the vegetation. Within this formation are tropical trees of the coastal plain further north, namely, mahogany, cedar, rosewood, "sapota," "santa maría," and cecropias, as well as less common kinds, such as fiddlewood, Jamaican dogwood, brazilette, lignum-vitae, blue mahoe, and the bread-nut. Further inland toward the headwaters of the creeks and rivers the cohune tends to disappear and there are virgin stands of mixed hardwoods from which, in many places, the mahogany and cedar have not been culled. Close to the rivers and in moist soil generally are larger numbers of fustic trees and big specimens of West Indian locust and "ceiba." Near the Yucatan border are extensive low and almost marshy areas with dense thickets of logwood.

The term "broken ridge" is frequently used to apply to low rolling foothills covered with a rather poor growth of hardwoods which become open and scattered in some places on the divides between the streams. This type is not nearly so extensive as is commonly believed.

The agricultural lands are mostly in the cohune areas and the principal crops are bananas, coconuts, sugar, cocoa, and some coffee. The timber industry is important and forms the basis for the foundation of the Colony; in fact, mahogany and logwood were exploited by the British as early as 1638. Mahogany and cedar were formerly obtained in the cohune lands, but the present source of supply is in the forests on

the limestone formations in the north. Large quantities of excellent timber are said to occur in the mixed hardwood forests above the rapids and falls of the small streams in the country south of Belize River, but it has been considered too difficult of access to attract operators. Not all of the mahogany and cedar exported from British Honduras originates in the Colony, some of it coming down the Belize River from Guatemala, some emanating from Quintana Roo, Mexico.

Most of the logwood is shipped to Europe, probably less than 500 tons being exported annually to the United States. Fustic is plentiful along the borders of the cohune ridge and supplies a well-known article of export, chiefly to England. Another wood of some importance is the so-called Honduras rosewood (probably a species of *Dalbergia*) so highly esteemed for xylophone bars. Lignum-vitae occurs in commercial quantities, but is rarely exported. There is an abundance of native pine timber of good quality, but inasmuch as it is all privately held and not now operated, British Honduras imports annually from the United States nearly $100,000 worth of rough lumber and lumber manufactures, chiefly yellow pine.

GUATEMALA

Guatemala, the name signifying "land of forests," extends entirely across Central America and has a coast line of about 110 miles on the Caribbean and about 170 miles on the Pacific. The total area of approximately 48,000 square miles supports a population of two million. The general topographic features are similar to those in southern Mexico, namely low coastal plains and an interior plateau of about 4000 feet elevation surrounded and broken by high mountains.

The littoral forest along the Caribbean is a continuation of the mangrove formation already noted in British Honduras. Back of it is the usual lowland tropical forest jungle with scattered areas of savanna or grassland. Such forests are of little economic value, because of the intermingling of low worthless palms, climbing plants, and so-called forest weeds such as the cecropias, figs (locally called "matapalo"), bamboos, and tall ferns. On the better drained areas are more open forests which remain fairly constant in general character and composition up to 1500 feet, beyond which pine predominates. In places in the east, pine approaches the coast as it does in British Honduras, but west of the continental divide it is rarely found below 1200 feet, while on all the interior slopes it is the principal tree, often growing to the tops of the highest volcanoes. Extensive areas around Lake Yzabal and in southern Peten, which were cleared for agricultural purposes by the Central American Indians in pre-Columbian days, are now either open grass

Photo by H. C. Kluge.

Cohune Ridge in British Honduras.

Photo by H. C. Kluge.

Pine Ridge in Republic of Honduras.

land or grass with a scattered growth of pine and oak, the progress of reforestation being extremely slow. The hardwood forests immediately surrounding the grass and pine areas occupy lands that were too poorly drained for the Indians' agricultural purposes. Northern Peten contains excellent forests of mahogany, cedar, chicle, and various other hardwoods such as are common in British Honduras and Yucatan, though interspersed with open grasslands. Mahogany and cedar logs are transported down the Usamacinta to Frontera, Mexico, and also down the Belize River to Belize, British Honduras, for export.

Most of the arable land of the interior plateau, on which Guatemala City is located, is under cultivation and little of the original forest remains. Extensive areas which appear wooded from a distance are in reality planted with coffee and cocoa. About the only timber of value on these interior uplands or on the slopes of the peaks is pine and oak. The forests along the rivers consist chiefly of a dense growth of cohune palms, "matapalo," and an impenetrable tangle of vines. On the somewhat better drained soils are mixed stands of mahogany, cedar, fustic, "ronron," logwood, West Indian locust, rosewood, sand-box, and "santa maría." These species average not more than one tree to the acre, though in a few favored locations on the lower foothills "santa maría" grows in pure stands. The common trees at higher elevation are "palo de cortez" (*Tecoma* sp.), "quiebrahacha" (*Sloanea jamaicensis* Hook.), balsam, calabash, hog plum, oaks, alders, and hop hornbeam.

The average yearly exports of woods of all kinds amount to about 3000 tons. Cedar is somewhat more plentiful than mahogany, but it is exported in considerably less amount because there is good local demand for it. Honduras rosewood is cut in a small way for export, chiefly from Livingston and Puerto Barrios. As to the dyewoods, fustic is available in considerable quantities, but recent shipments of this wood have been few and small; brazilwood is found only on the Pacific coast and is rarely cut; and although logwood is plentiful on the east coast, exploitation is very limited. Pine, "ronron," and "santa maría" are cut in places for local consumption; "genizero," "guanacaste," and "prima vera" are shipped in both log form and lumber to San Francisco, California. Lignum-vitae is found in all the lower forest belts on both sides of the divide up to an altitude of 2000 feet and the wood is employed for making axles, mallets, and for other purposes requiring a very hard material; small lots were shipped to Germany before the war.

Guatemala imports annually about $300,000 worth of yellow pine lumber and lumber manufactures, chiefly from the United States, in spite of the fact that her own forests contain an abundance of pine and other timbers suitable for all her needs.

HONDURAS

Honduras fronts on the Caribbean Sea for a distance of about 400 miles, while its Pacific coast line is only about 60 miles. The total area is about 44,000 square miles and the population is approximately one-half million. The interior tableland slopes very abruptly on the Pacific side and very gradually on the Atlantic, though in places the mountains rise almost from the sea. The mean altitude of Honduras is considerably less than that of Guatemala and there are fewer lofty peaks. Numerous rivers rise in the interior and meander northward and eastward to the sea, the largest being the Ulua which drains an extensive region and discharges more water into the Atlantic than any other river in Central America except perhaps the Segovia which forms part of the eastern boundary. The Aguan, Negro, and Patuca are all important rivers flowing into the Atlantic. The chief river on the Pacific side is the Choluteca, draining into the Gulf of Fonseca. Yohoa, the only lake of note, is 25 miles long and three to five miles wide.

Along the Atlantic coast are extensive mangrove swamps varying from few to 50 miles in width. Beyond these the land rises abruptly near the Guatemala frontier but farther east toward Nicaragua the incline is gradual until the broken interior is reached where the altitude varies from less than a thousand feet, as in the depression of the continental divide, up to nearly 10,000 feet in the mountains of Selaque. There are interior belts of elevated grasslands with little or no timber, a type fairly common at high elevations. The tropical jungle holds sway along the north coast and for miles along the streams where the land has not been cleared for agricultural purposes. Some distance back from the lower flood plains there are mixed hardwood forests of more valuable trees extending for miles into the interior. Along the Guayape or Patuca and the Guayambre, mahogany, cedar, fustic, logwood, and balsam are found in abundance. Cedar is of general occurrence in all departments; rosewood, "ronron," and logwood are chiefly on the north and east of the great divide; fustic, brazilwood, and "guayacan" are confined mostly to the Pacific slope. Guayacan is said to be found in great abundance on the plains of Comayagua, as are also oak, pine, "almacigo," "ceiba," and many species of figs.

The Pacific littoral of Honduras is limited to the Gulf of Fonseca which forms one of the best harbors in the world. Amapala, located on one of the small islands 30 miles from the mainland, is the only Pacific coast port. The forests along the Choluteca and its tributaries have been rather heavily exploited and very little cedar and mahogany remain. Formerly many sailing vessels bound for England called at

Amapala and loaded cedar, mahogany, dyewoods, yellow guayacan, lignum-vitae, "ronron," and rosewood, the logs being accepted by the captains as ballast at very low freight rates. During recent years the shipments of woods from this port have consisted chiefly of fustic and brazil.

Pine is the most common tree in all the elevated parts of Honduras, being very plentiful about the great plains of Sual in the west and on the savannas bordering the rivers and lagoons east of Truxillo. Nearly all of the pine forests on the northern slopes are readily accessible, the trees are well formed, and the timber is excellent for general construction work. At present, however, Honduras imports from the United States and Canada considerable quantities of yellow pine and Douglas fir. During 1920 the total value of the imports of lumber and manufactures of wood of all kinds amounted to more than a million dollars.

Cedar is used locally more extensively than any other wood and for this reason the exports are small. The mahogany trade in Honduras is as old as in Belize. During the middle of the sixteenth century the Spaniards requisitioned mahogany for shipbuilding and the early buccaneers frequently landed along the Honduran coast and bargained with the natives for supplies of mahogany logs for which there was a market in Europe. The timber has retained its importance in the trade and there are still considerable quantities available.

Lignum-vitae is more or less common along the northern slopes and near the coast, but the logs are mostly small and have a high proportion of sapwood. Rosewood occurs throughout the lowland forests and at one time large quantities were cut along the Segovia or Wanks River, but so many difficulties attended its exploitation that the industry gave way to the cutting along the Ulua and the small rivers in Guatemala flowing into the Gulf of Honduras. Small shipments are now made from Puerto Barrios and Livingston. Logwood, fustic, and brazilwood of the Gulf coast regions were formerly exploited much more than they are now; fustic is available in commercial quantities all over the Republic, but at present this wood is not being cut along the Atlantic seaboard, though occasional small lots of both fustic and brazil are being offered from Amapala.

SALVADOR

Salvador is the smallest, richest, and most densely populated of the Central American Republics. It occupies a strip 60 miles wide and 140 miles long between Honduras and the Pacific and has an area of 8000 square miles. The people number about a million and a quarter, or nearly 150 to the square mile, and are engaged in agricultural pursuits.

The surface configuration is so diversified that there are suitable locations for growing all kinds of tropical crops. Nearly all of the arable land is under intensive cultivation and such forests as remain have been materially modified through human agencies.

Two main mountain ranges cross the Republic. Along the coast is a narrow alluvial plain which gives way rather abruptly to a ridge consisting of a series of volcanoes, some of which are over 7000 feet high. Beyond this coast range is an interior valley or plateau of about 2000 feet elevation and still farther inland is the mother range of mountains giving rise to the branches of the Lempa River which waters the greater part of the Republic and is navigable for nearly half its length. The Pax River, which rises in Honduras and forms part of the western boundary, is navigable for only a short distance. The Guascoran River forms part of the eastern boundary and flows into Fonseca Bay. Salvador has no natural harbors, but the principal ports of call for steamers are Acajutla, La Libertad, and La Union, the last being on Fonseca Bay. Steamers anchor outside the heavy surf.

Coffee and cocoa, two of the important crops, require shade for their best development and the effect produced at a distance is that of a well-timbered country. While the forest trees are of the same species as in Guatemala, they are less abundant. There are some apparently virgin forests along the rivers, but the timber is more valuable for local consumption than for export. The lower slopes of the mountains contain considerable quantities of oak and pine, while higher up are belts of pure pine now being exploited in the more accessible places. There are numerous small modern sawmills located all through the populous portions of the country, but the operators depend in part on shipments of logs from Nicaragua and Guatemala. The local lumber supply is insufficient for domestic uses and the annual imports of lumber of all kinds from the United States amount to about $100,000.

Fustic is available in various parts of the Republic and fairly large quantities are cut in the region of La Union, chiefly for the European trade. Brazilwood is available in small quantities. A timber of local esteem is the "tatascame" (*Perymenium*), which grows gregariously on the slopes of the mountains from 2400 feet upward; the chestnut-like wood has many uses and is particularly suited for the manufacture of charcoal.

Another industry of note in Salvador is that of gathering the so-called "balsam of Peru." This is the resinous product of a leguminous tree (*Myroxylon*) native to that portion of the Pacific coast of Central America known as the Balsam coast, a tract of land, formerly a part of Guatemala, extending from Acajutla to La Libertad. Balsam was

originally the only article of export and is still the most important commodity of the region.

NICARAGUA

Nicaragua, largest of the Central American Republics, has an area of 49,200 square miles and a population of approximately 700,000. Its Atlantic coast line is 300 miles long and that of the Pacific 200 miles. About half of the land area is wooded.

The interior highlands are a continuation of the great Central American Andean system. On the east is the broad Atlantic plain traversed by numerous long rivers rising in or beyond the main cordillera which forms the eastern wall of the great interior lake basin. The latter is bordered on the west by the Pacific coast range, a series of volcanoes forming a ridge higher than the main line of mountain ranges entering Nicaragua from the north. To the east of the coast range which forms the watershed between the Pacific and Atlantic Oceans, is the Pacific coastal plain with its few small streams which are generally lost in the fringe of mangrove swamps. At the extreme north end of the Nicaragua littoral is the Gulf of Fonseca and some forty miles to the southeast is Corinto which has one of the best protected harbors on the Pacific coast of Central America. At the extreme southern end bordering on Costa Rica is Salinas Bay, on which San Juan del Sur is located. Beyond these lowlands are terraces leading up the coast range, and to the west is the great interior lake basin which includes Lake Nicaragua, about 110 miles long and 40 miles wide.

To the east and north is an irregular mountain system with numerous side spurs gradually descending to the Atlantic coast. The few low hills reaching the ocean on the east form an excellent port about sixty miles north of the entrance of the proposed Nicaragua Canal. The only other harbors on this coast are Gracias á Dios at the extreme north, Bluefields at the mouth of Bluefields River, and Greytown near the mouth of the San Juan. Southward from the Wanks or Segovia River, the longest in Central America, are many streams flowing into the Atlantic. Notable among these is the San Juan, with a total length of 140 miles and considered the most important stream in Central America inasmuch as it provides a waterway from the ocean to the important cities of the interior lake region as well as to the capital itself, there being steamship service between Greytown on the coast and Granada on Lake Nicaragua. The San Juan has many large and small tributaries, some with their source in Nicaragua, others in Costa Rica.

The Segovia River rises in the eastern crests of the cordillera and courses through mountain passes, undulating plains, and picturesque

valleys for a distance of 300 miles before emptying into the Caribbean Sea. It is navigable for some 240 miles, the upper 110 miles for light-draft vessels only. No other river in Latin America has such a diversity of names, the first 50 miles from its source being known as the Somoro River, while further down it bears the names of Cabrugal or Cadrullal, Coco or Cocos, Yoro or Yare, Portillo, Liso, Tabacac, Encuentro, Pantasma, Segovia, Gracias or Cape River, and Hervias River, and at its very mouth the English call it Wanks or Yankes River. Other important streams are the Grande or Matagalpa, named "Barra del Desastre" by Columbus who is said to have lost a boat and some men while disembarking in its turbulent waters; the Mico, known as Bluefields at its mouth; the Rama, navigable for some 40 miles to the city of Rama; and the Rio Grande, one of the largest streams, though only partially navigable because of its dangerous rapids.

In going up the rivers from the east, after leaving the mangrove swamps, one first encounters along the banks a narrow belt of low trees and palms overgrown with vines, while outside these thickets are extensive grassy areas sparsely dotted with patches of woodland. Further inland, where the soil is better drained, there are belts of pine and palm along the rivers in the north, but these are said to be absent in the south, as for instance along the Bluefields and its tributaries. The foothills and beyond are covered with the characteristic tropical rain forest composed of rubber trees, cedar, mahogany, "santa maría," "ceiba," "balsa," "ronron," "almendro," and many other important species.

The rain forests extend upward to the region where the clouds from the Atlantic come in contact with the slopes or eastern terraces of the central cordillera, whereupon the character of the vegetation changes abruptly. Oaks first predominate but the relative abundance of pine in mixture gradually increases, culminating in pure open stands toward the crests of the ridges. Going down the western slopes, one passes through the so-called "llanos," a semi-arid region with scattered trees and occasional areas under cultivation. The oaks predominate at lower altitudes, giving way to grassy upper plains with only here and there an unimportant growth of calabash and other low shrubby plants locally known as "matorrales." Next appears the rain forest similar to that of the east slope. In the plains below, the soil is often swampy and in many places rocky and the only tree growth consists of small oaks, fustic, brazil, lignum-vitae, cacti, agave, and bromelias.

The lower slopes and warmer flat lowlands of the interior lake region are clothed with the usual tropical tree species already noted, though on the plains are many grassy areas useful only for grazing. This interior basin contains the bulk of the population and the cities. It also

supplies most of the timber used locally or exported from the west coast. The prevailing trees are "pochote," "guácimo," "guanacaste," "elequene," "espino madroño," and various cecropias.

On the eastern slopes of the coast range, the best region for growing coffee, there are extensive forests of valuable timber, including cedar, mahogany, brazil, "guanacaste," "genizero," "cortez," cocobolo, lignum-vitae, fustic, "laurel," "guachipilin," and various others of commercial importance. Oaks and pines cover the upper slopes of the volcanoes, the pines growing to the very top of the peaks wherever there is enough soil to afford them a footing.

Mahogany is obtained from the east coast and between two and three million feet are exported annually. Sawmills operating in mahogany are located at Gracias and Bluefields. Cedar is exploited along with mahogany on the east coast and considerable quantities are obtained also on the west coast; it is more plentiful than mahogany and has many more local uses. "Genizero" is common on the coastal lowlands and throughout the lake region and the lumber is used locally for carpentry and general construction; a few hundred tons are exported annually, chiefly to San Francisco. Cocobolo, locally known as "ñambar," is exported under the name of rosewood from Corinto and San Juan del Sur, the total value of the shipments being from ten to fifteen thousand dollars annually. The logs are hewn free of sap and, while often hollow, supply a good grade of material for knife handles and small articles of turnery. Nicaraguan lignum-vitae (probably *Guaiacum guatemalense* Planch.), has been known to the trade for more than 50 years, but has not been so highly esteemed as that from Cuba. It is probable, however, that the future demand for large-sized lignum-vitae logs will be largely supplied by Nicaragua since apparently the trees reach larger dimensions there than elsewhere.

The dyewoods, so common all along the west coast from southern Mexico to Panama, are found in commercial quantities in Nicaragua and their exploitation constitutes one of the chief forest industries. Fustic grows along all the streams throughout the Republic, but the timber growing to the west is more highly esteemed than that growing to the east of the cordillera. The annual output varies from one to three thousand tons, nearly all of which is exported to Europe, particularly to France.

There are a number of sawmills in the Republic cutting pine, cedar, mahogany, "genizero," "guanacaste," "ronron," and numerous other native timbers to meet local requirements. A gradually increasing use is made of native pine growing on the upper slopes of the mountains, and the importation of American softwoods is gradually decreasing.

During 1919 the value of the declared exports of lumber from the United States to Nicaragua was $125,000, while the value of Nicaragua's exports of wood to all countries was about $1,500,000.

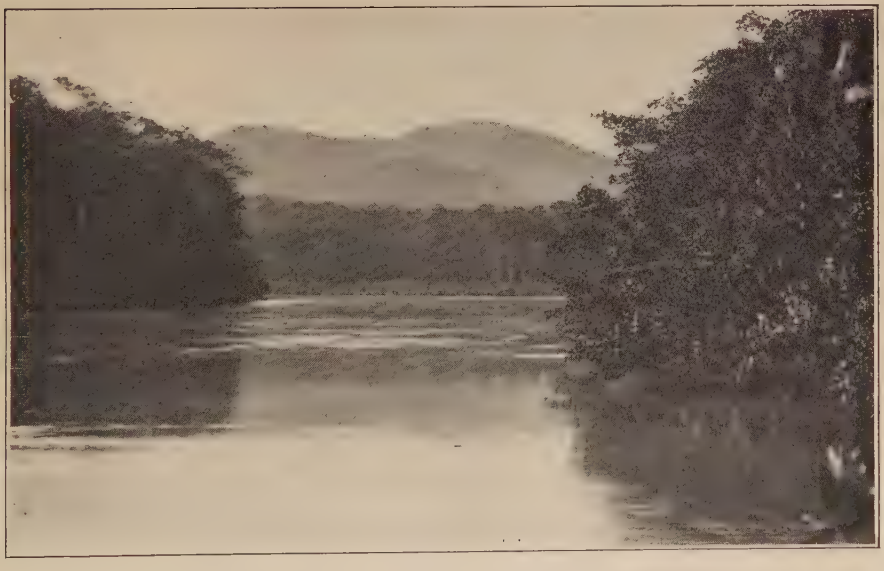
COSTA RICA

Costa Rica, the name signifying "rich coast," lies between Nicaragua and Panama and has an area of 23,000 square miles. The Atlantic coast line is regular, but that on the Pacific side is indented toward the north by the Bays of Salinas and Culebra and to the south by the Gulf of Nicoja, Coronado Bay, and Gulf of Dulce. The topography is not strikingly different from that of the neighboring republics. The same general mountain system forms the high central ridge or cordillera, broken by irregular transverse depressions. To the north are the volcanic mountains culminating in the peaks of Turialba and Irazu about 11,000 feet above the sea. The main ridge, known as Sierra Tiliran, forms the watershed between the Tempisque River on the west and the valley of San Juan on the east. To the south of the main depression, which extends between Port Limon and Puntarenas, is a central ridge known as Sierra de Talamanca or Chiriqui; it has numerous side ranges east and west which give rise to many small streams that are short and swift on the west coast and somewhat longer, though not navigable, on the east.

Costa Rica is one of the most progressive of the Central American Republics. For the most part the country is healthful, especially in the interior plateau region where enterprising communities have been developed. The lowlands in the east are prolific in the production of bananas, cocoa, coconuts, and other tropical products; higher up are extensive areas where coffee and cane are grown; and the tablelands, where the arable portions have been cleared, are well adapted to corn, potatoes, and other temperate crops. Coffee continues to be the most valuable product of the higher lands of San Jose, Heredia, and Alajuela. All told, however, only about 5 per cent of the land area is under cultivation.

Along the Atlantic littoral the usual mangrove swamps prevail and immediately back of this formation, which varies in width from a few yards to several miles, is a dense virgin forest so difficult to penetrate that its general character and extent have been studied only from the rivers and from the high mountains in the interior. Because of its luxuriance the forest south of the San Juan River has been termed the "Central American Hylaea." It is a true rain forest and occupies the entire Atlantic region, comprising more than two-thirds of the Republic. This type extends inland and upon the Atlantic terrace lands to an

A Sawmill in Costa Rica.



A Tidal River on West Coast of Costa Rica.

altitude of 6000 feet, with very few savannas. The forests vary in density, but very little in composition up to 2500 feet, except that the palms, vines, ferns, and other less important species decrease with the rise in elevation. Along the rivers and near the coasts are forests of palms, chief of which are the "coyol" (*Acrocomia*), "corozo" (*Attalea Cohune* Mart.), "biscoyal" (*Bactris horrida* Oerst.), and "palmiche" (*Elaeis melanococca* Gaertn.). Prominent among the hardwoods are "roble," "ceiba," West Indian locust, rubber trees, cedar, mahogany, "santa maría," "sapota," and species of *Enterolobium*, *Caesalpinia*, *Copaifera*, and *Pithecolobium*. The pines, so conspicuous in Nicaragua and northward, entirely disappear in Costa Rica. At the higher altitudes the oaks continue through to the southern high mountains. The oak region slopes down gradually and in the province of Guanacaste one species (*Quercus citrifolia* Liebm.) occurs only 300 feet above sea level. The upper limit of the oak region is reached at an altitude of about 8500 feet.

On the Pacific slope and plain the wet and dry seasons are plainly marked, and during the rainless summer the herbaceous vegetation almost disappears and practically all the trees and shrubs shed their leaves so that the forest and general landscape are in decided contrast to conditions on the Atlantic side. The river valleys and the moist lower slopes are clothed with evergreen vegetation, but generally speaking, the flora of the Pacific coast may be attributed to a more northern origin.

The immediate Pacific littoral forest zone is very narrow except in the region of Golfo Dulce and at the mouth of the Tempisque River, where it is several miles wide. The principal trees are the same as on the Atlantic side, namely the white and the black mangroves, coconut, calabash, manchineel, hog plum, "guapinol," and species of *Acacia* and *Caesalpinia*. Back of this type the forest is open and park-like with savannas here and there, except along the streams where the growth is dense. Higher up, on the moist lower slopes, are virgin forests interspersed with meadows dotted with single trees or clumps, and sometimes with a dense growth of shrubs or "matorrales." The savannas and open forests are characteristic of the northwestern part of the Republic, being continuous with those of Rivas in Nicaragua. The Peninsula of Nicoya is perhaps the best timbered area on the Pacific side of the continental divide and has been the source of valuable woods, especially cedar, "pochote," mahogany, and dyewoods.

The forests of Costa Rica are less extensive than is generally supposed. Although there are over one hundred species of indigenous trees yielding logs large enough for lumber, comparatively few of them are

now being utilized. Conifers do not exist in commercial quantities and many of the principal hardwoods are too scattered to be made available for house construction and general building purposes. Cedars and "pochote" comprise fully three-fourths of the domestic lumber consumed in the Republic and are highly esteemed because they are easy to work and very resistant to decay and to the attacks of ants. They are much preferred to American pine, although imports of the latter amount to about a third of a million dollars annually.

Spanish cedar is the most important timber in Costa Rica for local use and for export. Of the eight million feet produced annually, about a third is exported, chiefly to Peru and the United States. Mahogany occurs sparingly along the water courses of the west coast and is of much less importance than the cedar. "Pochote" yields a wood resembling cedar and is of considerable local utility, but has not been successfully introduced into foreign markets. Cocobolo is rarely used locally, but about a thousand tons are exported annually, mostly in the form of hewn logs six to eighteen inches in diameter and up to ten feet in length. Limited amounts of brazil and fustic also enter foreign markets, and during the war some balsa logs were shipped from Port Limon. The total value at port of origin of all timber now being exported from Costa Rica does not exceed $200,000 annually.

The timber industry of Costa Rica is almost entirely confined to the west coast, being centered in Puntarenas, a town of 3000 inhabitants owing its origin and prosperity largely to the coffee growers in the interior. Some forty years ago it is said that two large schooners a month were loaded in Puntarenas with cedar and mahogany logs and the business was highly profitable. The trade is still important, but the easily accessible timber has been removed and the increasing difficulties of logging require much more capital than formerly.

There are about ten cedar trees to one of mahogany on the west coast and further back in the hills the mahogany disappears entirely. The mahogany of this region is only slightly heavier than cedar and often floats even when green. Logs of most of the species are heavier than water and raft-logs of defective cedar are used to buoy them up in transit down the rivers.

The dyewoods, fustic and brazilette, have a white useless sap that is removed in the bush. The pieces are very irregular and range in diameter, after hewing, from five inches up to two feet or more. Since they are too heavy to float they are hauled to some convenient point on the Gulf of Nicoya and there loaded on punts or boats having a capacity of from 50 to 300 tons for transport to Puntarenas. The building of these punts is an important industry in Puntarenas. The frames are made of "geni-

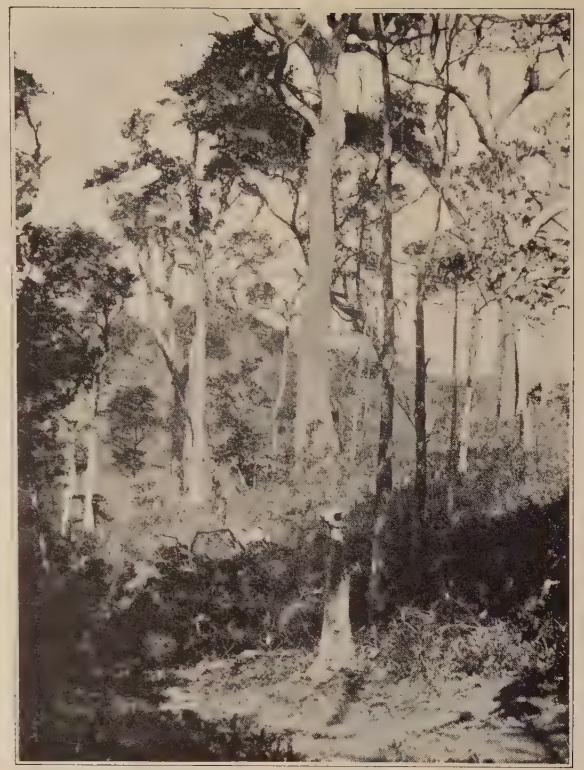


Photo by C. D. Mell.

In the Spanish Cedar Forest of Costa Rica.

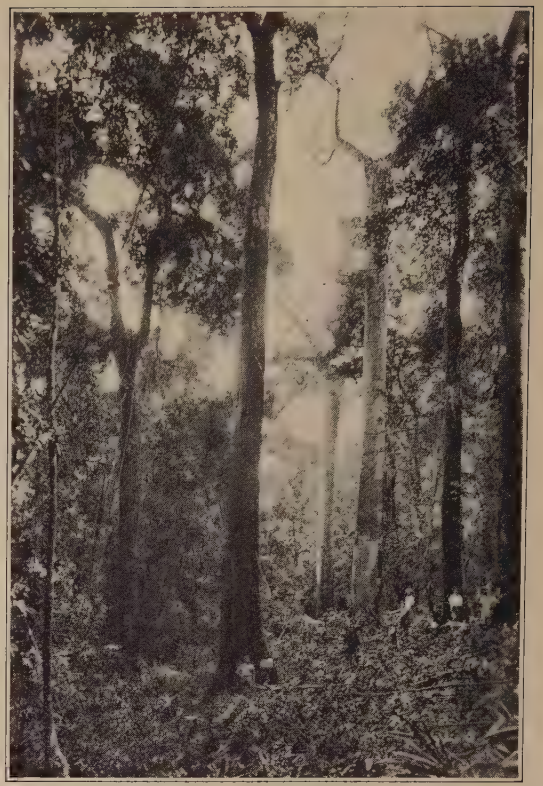


Photo by Panama American Timber Corp.

In the Mahogany Forest, Congo River, Panama.

PLATE IX

zero" and the planking is generally of cedar or "santa maría." Vessels loading at Puntarenas are obliged to anchor some distance from the shore. Cedar logs are rafted alongside, but the heavier woods must be lightered, a time-consuming and expensive procedure.

PANAMA

Panama, the sickle-shaped neck of land connecting the American continents, is 430 miles long and from 31 to 118 miles in width, and its area of approximately 33,000 square miles supports a population of nearly half a million. Its topography differs somewhat from that of the rest of Central America. The mountains in the eastern half are for the most part irregular and round-topped without definite arrangement and marked in several places with low depressions, such as the Isthmus of Panama,[5] the Isthmus of San Blas, and the Isthmus of Darien. The Isthmus of Panama coincides in part with the Chagres River Valley, which is not over 300 feet above sea level. In the western half of the Republic the mountain system is less broken. The highest elevations are the volcano of Chiriqui, which is over 11,000 feet, and Santiago peak, over 9000 feet high. The headlands of the peninsulas of Azuera and Los Palmos rise to the altitude of 3000 feet and terminate abruptly at the coast.

There are very few areas of level land in Panama. For the most part the hills rise abruptly from the water's edge and not far inland attain an elevation of several thousand feet. There are limited stretches of lowland along the Chagres and the Pacific coast east of Panama City, but they are generally swampy and covered with a dense jungle of mangroves, manchineel, wild fig, and other trees which do not yield merchantable timber. In many places along the north coast and east of Colon where the mountains reach the shore, drought-resisting oaks form stands of varying density, grading into open park-like forests with palms, mesquite, and "corotu" (*Enterolobium*) predominating. During the dry season the flat elevated areas are constantly swept by the trade winds which blow through the deepest depressions in the central cordillera, and trees thrive only in sheltered locations.

The entire Republic is well watered. About 150 rivers drain into the Caribbean Sea and more than 300 into the Pacific Ocean. On the Caribbean slope are two main rivers, the Sicsola near the western boundary, and the famous Chagres which now supplies water to the artificial lake through which the Panama Canal passes. On the Pacific side is the

[5] This term is generally applied to the whole country, but here refers to the narrow crossing between the cities of Colon and Panama.

Chepo or Bayano flowing into the Gulf of Panama. Farther to the east the Tuira empties into San Miguel Bay and, with its many tributaries, is the longest river in the Republic.

On the Atlantic slope and near the Costa Rican frontier is Almirante Bay, a prolongation of Chiriqui Lagoon; it is about thirteen miles long and varies in width from two to ten miles. It contains many small islands and affords good harbors for ocean-going steamers. Its main entrances from the sea are Boca del Drago and the Boca del Toro. Regular steamer service is maintained for the purpose of loading bananas. Chiriqui Lagoon is 12 miles wide and 32 miles long, and vessels of any draft can enter it by Boca del Tigre. To the east is the Bay of Colon on which Colon is situated, the Bay of San Blas, and the Gulf of Uraba. On the Pacific side, beginning at the extreme west, are David Bay, Montijo Bay, Parita Bay, Panama Bay, and the Gulf of San Miguel or the Darien of the South.

Probably in no other tropical American country has the forest flora been so thoroughly studied as in Panama. Although limited areas remain little known to white men, the country on the whole has been carefully mapped and its forest and other resources noted by numerous prospecting and exploring parties. Forests are distributed more or less uniformly except on the ridges and upper rocky slopes of the highest ranges and peaks, the dry wind-swept areas in the Province of Chiriqui near the city of David, and the treeless savannas along the Pacific coast east of the city of Panama. Approximately 85 per cent of the total area is covered with some sort of forest growth, a larger proportion than in any other Central American country.

Except on the small elevated mesas which are covered with an open and stunted growth of oaks and palms, the forests throughout the interior are almost as purely tropical in character as those on the low coastal plains. While the "tierras calientas" or hot lands and the "tierras templadas" or temperate regions may be distinguished in Panama as in the countries farther north, the differences in the forest flora of the two zones are less pronounced since many of the species growing abundantly along the coast occur also in the more elevated interior. On the Caribbean side rains occur the year round, but on the Pacific side there is a dry season lasting from December to May.

Chiriqui is the most densely populated region in Panama and a number of introduced tree species, such as the tamarind, mango, and Indian almond, are planted extensively around all dwellings. Forests exhibiting the true tropical character occur only along the rivers, attaining their greatest luxuriance to the west of David along the Chiriqui Viejo and to the east between Gualaca and Horoconcitos. From David inland

Photo by Panama American Timber Corp.

Native Village on Congo River, Panama.

Photo by Panama American Timber Corp.

Towing a Raft of Mahogany Logs in Panama.

(northward) toward the base of Chiriqui volcano are many square miles of bare wind-swept country supporting in the open only tufts of grass, sedges, and other small plants, and in protected places stunted groves of twisted and gnarly trees. In the deep ravines at some 3000 feet elevation there is a mingling of the tropical and the sub-tropical species. Large elms, so conspicuous in the rain forests of Mexico, grow with magnolias, alders, and species of *Tecoma* and *Persea;* oaks occur in mixture with palms and figs. At 6000 feet there are whole forests of *Persea*, and at still higher altitudes and on the protected slopes of the broken ridges surrounding the crater of the Chiriqui volcano are dense forests of myrtles, oaks, and less familiar kinds which have close allies in the more temperate climates. East of Chiriqui, park-like forests are found only on the ridges of the highest mountains where vegetation is dwarfed by the perpetual winds. On the slopes and along the streams the growth is luxuriant and almost impenetrable.

As already outlined, the entire Atlantic slope of Panama is densely wooded and very little clearing has been done, because of the heavy rainfall all along the northern seaboard. About the only agricultural industries are the growing of bananas and coconuts in the regions around Chiriqui Lagoon and Almirante Bay. The forests are largely intact and probably will remain so for many years, since it is not now feasible to undertake extensive operations to the north of the central cordillera. The timberlands now accessible are on the Pacific slope, but they are the scene of very few lumbering operations. There are less than half a dozen sawmills in the Republic and the bulk of the required number is imported. During 1920, over one and a half million dollars' worth of lumber of all sorts was obtained from the United States, while during 1913 as much as fifty million feet of Douglas fir, pine, and other woods of United States origin was used, chiefly in and around Panama City. Practically all the railroad ties are of creosoted cypress, yellow pine, and Douglas fir, although there are many native woods reported to be suitable for this purpose.

Attempts by American, British, and German corporations to establish operations on holdings in the region bordering the Bayano River have not met with success. During the war the United States Government on the Canal Zone started to saw logs of local origin, but the operation on a large scale was soon abandoned, partly because of difficulties in seasoning the lumber and also on account of the inability to produce it cheaply enough to meet outside competition.

The best known timbers are mahogany, cedar, sand-box, "coratu," "santa maría," "espavé," "almendro," "nispero," "guayacan," "roble," and several kinds of balsam and "amarillo." There are many others

available, but their uses are very restricted. Mahogany is found chiefly on the Pacific slope and in the upper reaches of the Chagres and Sicsola rivers in the west and has been reported in the region bordering the tributaries of the Tuira. It is not extensively exploited and is not likely to be very soon. Cedar occurs on somewhat higher land and its exploitation is a formidable task, because of the difficulty of floating the logs down the rivers which during the rainy season are raging torrents and during the dry season are very shallow. Thus far the bulk of the Panama cedar and mahogany for export has originated chiefly along the Chagres River, down which the logs are floated to the lake and transported by rail to Cristobal.

"Espavé" (*Anacardium*) often attains enormous size, with a long, clear and cylindrical bole yielding a rather soft wood used in a limited way locally. Attempts to find a foreign market for it have so far failed, partly at least because the dealers tried to dispose of it as mahogany. "Guayacan" (*Tecoma*) has been exported as lignum-vitae, but, lacking the self-lubricating properties of the latter, is unsuited for bearings. "Almendro" (*Dipteryx*) is more or less common in the forests of Panama and its trunks attain great height and are quite cylindrical to the top; its excellent wood is much sought after for making the spuds in the large dredges used in the Canal. "Coratu" (*Enterolobium*), an easily worked wood closely related to the "guanacaste," is occasionally shipped to San Francisco. "Santa maría," so common in Mexico and southward, is abundant on the moist foothills and middle slopes and supplies one of the best woods for local use in Panama. Cocobolo is the best known Panama wood in the American markets; the present supply of logs is obtained chiefly in the region of the Chagres River. The only dyewood thus far exploited in Panama is fustic or "mora." It is very common, especially on the Pacific side, and during the war considerable quantities were obtained in the region of Chiriqui. Black palm (*Astrocaryum* sp.) supplies slender logs, the hard outer portion of which is used for the manufacture of fishing rods.

SOUTH AMERICA

South America, fourth in size among the continents of the world, includes by far the greater part of the land surface of tropical America. About six-sevenths of the continent lies south of the equator and the whole is east of the meridian of longitude passing through Charleston, South Carolina. Its total length from north to south is approximately 4800 miles and its greatest width is probably a little short of 3200

miles; the total area, including the small islands which may be considered a part of the continent, is about seven million square miles, or a little less than that of North America.

South America is readily divisible into three great natural regions. Along the western side is the gigantic mountain mass known as the Andes, consisting for the most part of a double chain of cordilleras and sierras having a mean elevation of 14,000 feet, while numerous peaks, many of them active volcanoes, exceed 20,000 feet. The portion of this great elevated region that is over 10,000 feet above the sea comprises about 6 per cent of the continent. Extending along the eastern side from the Guianas to Paraguay are the so-called Brazilian Highlands, bisected by the Amazon River. The northern portion, known as the Guiana Highlands, occupies southeastern Venezuela, the hinterlands of the Guianas, and a part of Brazil. Beyond the lowlands of the Amazon the surface again rises, forming the eastern Brazilian Highlands, mostly from three to four thousand feet in elevation, though near the coast and in the extreme south the maximum height is said to be 11,000 feet. The central lowlands consist of the Orinoco plain between the cordillera, the Guiana Highlands and the great Amazon Basin to the south. Approximately 42 per cent of South America's land surface is included within these and other fluvial regions that are not over 600 feet above sea level.

Although the greater part of South America has a tropical climate, the rainfall, which is dependent largely upon prevailing winds and ocean currents, is often too unevenly distributed to permit the development of dense forests. The true "selvas" occur along the rivers where there is generally abundant precipitation, as is the case also on the lower and middle slopes of the mountains which have a condensing effect on the clouds coming in contact with them. At varying distances back from the river banks where rainfall is scantier, conditions often change and savannas or "llanas" are the most characteristic features. At higher altitudes arborescent growth gives way to thorny scrubby areas known as "catingas," and the ridges of the cordilleras and the upper mesas, known as "paramos," are mere desert regions where low shrubs and hard grasses predominate.

While the forest areas for the individual countries are roughly defined in the following pages no attempt is made here to summarize these approximations, since there are such vast areas in South America of which no records are available as to the extent and character of their forests that total estimates would embody entirely too much guesswork to be reliable.

COLOMBIA

Colombia, the fourth largest country in South America, has an area of nearly 500,000 square miles and a population of about six millions, or about twelve inhabitants to the square mile. There is great diversity in elevation, climate, and soil, with a corresponding variation in the vegetation. Over the greater part the climate is distinctly tropical, but in certain localities it is temperate, and the higher mountains are capped with perpetual snow. The west and central portions, comprising two-fifths of the total, are mountainous and rugged, but the remainder is moderately level and entirely accessible.

There are three distinct climatic zones as in Central America, namely, the "tierras calientas," the "tierras templadas," and the "tierras frias." The first of these embraces all areas below an elevation of 5000 feet, such as the great region bordering Brazil, the western coast country and the mountains skirting the Pacific littoral, as well as considerable stretches of land in the north, exclusive of the Santa Marta Mountains, and along the rivers for many miles inland and up the mountain slopes for varying distances and elevations. In general, this zone is characterized by dense tropical forests, although there are extensive areas which are poorly forested.

The west coast is fairly uniformly timbered except for occasional stretches of open country which were probably denuded by the early settlers or aboriginal Indians, and which now serve, during a part of the year at least, as grazing lands. The forests are gradually giving way to cornfields and pastures, but the extensive methods of farming the rolling lands are impairing the usefulness of the region for either agriculture or forest production. In favored locations there are limited quantities of cedar, mahogany, fustic, brazil, and "albarco," as well as less important kinds such as cecropias, balsa, "ceiba," and various other soft-wooded trees. Numerous representatives of the family Sapotaceae yield chicle, and the rubber tree (*Castilla*) is common both in a wild state and in plantations. "Divi-divi" occurs on the ridges and well-drained areas, while the inundated coast supplies mangrove timber for general construction.

Along the Caribbean Sea the country is generally much more arid, the savannas of Bolivar, for example, affording a decided contrast to the dense growth in the Choco region drained by the San Juan. Just back of the mangrove formation the country is open and sparsely timbered except along the streams, the principal growth consisting of mesquite-like shrubs with occasional trees of "caracoli" and "ceiba." The wet and the dry seasons are well defined along this northern coast

Photo by H. N. Whitford.

Forest along Magdalena River, Colombia.

Photo by H. M. Curran.

Divi-divi Forest along Venezuelan Coast.

and soon after the beginning of the dry season the trees shed their leaves. At one time these lowland plains were probably covered with forests which were subsequently destroyed by fires, for which the white settlers rather than the Indians were presumably responsible.[6] On the lower slopes and moist coves farther inland the forests remain comparatively intact, although some cutting is going on in regions where the streams are large enough to float out the logs during the wet season. Mahogany and cedar occur where the soil moisture is sufficient for their development. Conditions are much the same throughout the entire coastal plain except that near the Venezuelan boundary there are vast stretches of grassland and low brush with only occasional patches of woodland. Farther inland along the foothills the true forests begin to appear. The well-known tropical trees already noted are all represented, but much of the growth consists of the less valuable kinds, such as palms, cecropias, and various representatives of the families Bombacaceae and Burseraceae.

The region drained by the upper reaches of the Orinoco and the Amazon embraces more than half of Colombia and much of it is still unexplored. Forests fringe the rivers, but they are in a measure disappointing on account of the abundance of vines and trees of secondary importance. Back from the streams more than half of the area is open grassland dotted with palms. The moisture-laden winds sweep over this low level plain to the eastern terraced lands of the Colombian plateau where, in consequence of the abundant rainfall thus produced, the slopes are covered with dense forests of a composition more distinctly that of the Atlantic coast than of the Choco region along the Pacific. Palms of many kinds occupy the lowlands, but near the rivers and on the slopes they give way to broadleaf trees.

In ascending the eastern slopes, one first encounters the rain forests, which gradually lessen in density until at elevations varying from 4000 to 6000 feet, depending upon the site and exposure, the temperate forests are reached. Although many slopes and protected mesas at 8000 and even 9000 feet altitude are covered with oaks, junipers, "laurel," and *Podocarpus*, the growth is generally dwarfed in such regions. The mesas in the central and eastern cordillera include strictly agricultural areas and support the greater part of Colombia's population. The temperate forests originally covered only about 15 per cent of the total area of Colombia and fully half of this has been cleared for the growing of coffee and, at higher elevations, corn, potatoes, wheat, and barley. Above the temperate forest belt the vegetation is scrubby and grades

[6] It is said that the aboriginal Indian never burned the forest, as he was interested in protecting the game upon which he depended so largely for his food.

into grass and other low ground cover. These open "paramos" often afford excellent grazing, but at still higher altitudes they become bare and wind-swept areas strewn with boulders and gashed with deep fissures which render travel difficult and perilous.

Pending the development of adequate transportation facilities, much of the timber in Colombia must remain untouched except along the rivers where selective logging is being practiced. Eventually these timberlands will become accessible and while some will be cleared for agriculture, more will be reduced to a useless jungle of tree weeds unless effective measures for conservation are instituted and enforced. Among the important timbers now available for export as well as for local use are cedar, "albarco" or the so-called Colombian mahogany, "comino," "palo santo," lignum-vitae, "copaiba," fustic, logwood, and some true mahogany. The bulk of these are at present obtained in the valley of the Atrato and Sinu rivers where sawmills are in operation. About a million and a half board feet of logs are exported annually to the United States and Europe, and small quantities of cedar are shipped to Porto Rico. Other forest products entering the trade are chicle, gutta-percha, ivory nuts, cohune nuts, "divi-divi," and cinchona bark. The Panama-hat palm (*Carludovica palmata* R. & P.), known locally as "toquilla" or "jipigapa," is the basis of an important industry and large quantities of the fiber are exported.

VENEZUELA

Venezuela has a coast line of approximately 2000 miles and a total area of about 600,000 square miles. Seventy islands and deltas aggregate about 25,000 square miles. There are about 138,000,000 acres of forest, 60 per cent of which contains commercial timber, though much of it is not now accessible. The population is somewhat less than three millions, or about five inhabitants to the square mile.

The country is divisible roughly into three irregular portions, namely, the mountains in the west and north, the Orinoco River Basin, and the Guiana Highlands. The first of these is an eastward ramification of the Andes extending to the region around Pamplona where it bifurcates, one division running northward to the Goagira Peninsula, the other eastward to Merida and thence in a northeasterly direction toward the Gulf of Triste and forming the Maritime Range. In the vicinity of Merida it is known as the Sierra Nevada de Merida, and culminates at a point called Picaha de la Sierra which is over 15,000 feet above the sea. This great mountain range, with its numerous peaks perpetually covered with snow and ice, separates the Lake Maracaibo

Basin in the north from the region drained by the Apure River, the main branch of the Orinoco. The Maritime Range parallels the coast and intersects a spur of the Andean Range at Barquisimeto in the Province of Lara. From an average elevation of about 4000 feet, this coast range gradually diminishes eastward to Cape Codera, but rises again between Cumana and the Gulf of Paria. The region known as Venezuelan Guiana occupies the southeastern portion of the Republic and consists of an irregular tableland with occasional flat-topped elevations, 4000 to 8000 feet high, with densely wooded areas intervening. Between the two highlands of Venezuela is a great interior basin, the Orinoco River Valley, which comprises fully four-fifths of the total area of the Republic. The Orinoco is about 1500 miles long, is navigable for nearly four-fifths of this distance, and is surpassed in size only by the Amazon and the Mississippi.

The forests of Venezuela occupy about half of the land area, and are as varied as the topography. For convenience of description they are divided into four types, namely, the dry forests, the monsoon forest, the rain forests, and the temperate rain forests. The dry forests comprise about 15 per cent of the forested area and include the barren coastal hills from Goagira Peninsula eastward to the Gulf of Paria, as well as all the islands along the coast and considerable areas in the interior of the States of Miranda and Bermudez. Since the trees and shrubs are, for the most part, stunted and spiny, such plant formations are known as "espinares" or thorn forests. The predominating species are the "pajui," "igüi" or "malarmo" (*Bumelia buxifolia* Willd.), various species of *Acacia*, and cacti such as the "guamacho" (*Pereskia* sp.), "nopales" (*Opuntia* sp.), and "cardones" (*Cereus* sp.), all of which are very thorny. Associated with them are the "atata" (*Esenbeckia Atata* Pittier), "quigua" or so-called West Indian sandalwood and "candil de playa" (*Amyris* spp.), "naranjillo" and "amargoso" (*Aspidosperma* spp.), "vera" (*Bulnesia arborea* Engl.), "guayacan" (*Guaiacum officinale* L.), and others of less importance.

The most abundant plants in the drier and upper belts of vegetation on the low coast range are species of *Croton*, forming low impenetrable thickets called "chaparrales." They occur in all dry places in the interior, usually at elevations below 3500 feet, and are common in Carabobo, Aragua, Miranda, and in regions bordering savannas or grassy plains. It is sometimes difficult to distinguish this formation from the growth, known locally as "matorrales," which develops on abandoned fields. In the most favorable locations are some large trees, such as the "almacigo," "volador" (*Gyrocarpus americanus* Jacq.), "ciruelo de hueso" (*Spondias purpurea* L.), "jobillo" (*Tapirira guia-*

nensis Aubl.), "majomo" (*Lonchocarpus Fendleri* Benth.), and "naranjillo bobo" (*Bravaista floribunda* DC.). In some places, as in the vicinity of Caracas, the "chaparro" (*Curatella americana* L.) becomes the dominant species in association with the "alcornoque" (*Bowdichia virgiliodes* H. B. K.), "chaparro manteca" (*Byrsonima crassifolia* H. B. K.), and other trees already mentioned.

The monsoon forests occupy about 30 per cent of the country. During the wet season they often assume the appearance of the true rain forests, but vines and other undergrowth are much less abundant. During the dry season when most of the species shed their leaves, they resemble the dry forests, but have a greater percentage of large timber trees. In a general way the monsoon forests occupy a belt between the dry and temperate forests on all the coast ranges and at the foot of the Andes, but attain their best development in Venezuelan Guiana where they are interrupted only by occasional small savannas and clearings. Along the eastern course of the Orinoco, the upper portions of all the rivers draining into it, and in the valleys of the Imataca Mountains, they yield the bulk of the rubber, balata, chicle, and tonca beans produced in Venezuela. The composition of the forest is not well known, but near the coast, as, for instance, in the states of Carabobo and Jaracuy where logging operations have been carried on, at least in a small way, they consist of "saqui-saqui," "habillo" or sand-box, "ceibo" or silk-cotton tree, "pauji," "carbonero" (*Mimosa* sp.), mahogany, "jobo," "gateado," "chupon colorado" (*Sideroxylon* sp.), "chupon ventoso" (*Gustavia* sp.), and many others of greater or less importance. This type is the home also of numerous palms, including the royal palm, wax palm, and several species of the genera *Attalea*, *Thrinax*, and *Cenocarpus* which attain their best development in loamy soil along the rivers.

The rain forests, comprising about half of the total, occupy the deep coves and ravines of the Andes, the region south and southeast of Lake Maracaibo, the valleys of Tocuyo, Turen, Ticopero, and San Camilo at the foot of the Andes, the Rio Negro Venezolano, the delta of Amacuro, and along the Caribbean coast eastward to British Guiana. The trees reach enormous proportions and it is not unusual to find trunks clear of branches for from 100 to 150 feet. The vegetation is so dense that the forests are rarely penetrated by white men, and for this reason extensive areas in the province of Zulia and in the region of Rio Negro are little known. The restricted and more accessible forests near the coast are composed of different species of *Couroupita*, *Lecythis*, *Gustavia*, *Mimusops*, *Virola*, *Brosimum*, *Pourouma*, *Ficus*, *Sapium*, *Vitex*, and many others. Mora (*Dimorphandra excelsa* Baill.) occurs along

Photo by H. M. Curran.

Mangrove Bark Depot on Shore of Lake Maracaibo, Venezuela.

Photo by H. M. Curran.

Camp of Indian Gatherers of Balata and Mangrove Bark, Orinoco Delta, Venezuela.

the rivers in the extreme east in association with crabwood. Greenheart, known locally as "viruviru," is said to be abundant near the Guiana border. The forests of the Rio Negro district are known best from Richard Spruce's report of 1854 in which he listed over 200 species of trees and about 30 species of palms. The genera best developed there are *Hirtella, Licania, Swartzia, Macrolobium, Virola,* and *Astrocaryum.* The littoral formations, consisting chiefly of mangrove swamps, may be included in the rain forests. The most important of these are in the deltas of the Orinoco and along the shore of Lake Maracaibo. It is not to be inferred that all of the rain forest area is covered with merchantable timber since, in fact, there are vast stretches which are nothing but jungles of interwoven vines, bamboos, tall grasses, and palms, without a single valuable tree for miles.

The temperate forests, or cold rain forests, comprise only about 5 per cent of the total. They begin at an altitude of about 5000 feet (though much depends upon the soil, exposure, prevailing winds, and proximity to the ocean) and extend upward to the limit of tree growth. Although temperate in character, they contain only a few arborescent genera found in the north temperate zone, the principal ones being *Alnus, Symplocos, Rhus, Styrax,* and *Persea.* Those that are more distinctly tropical are cedar (*Cedrela montana* Turcz.), *Trichilia* sp., and *Protium laxiflorum* Engl. Some of the other arborescent genera represented are *Aniba, Nectandra, Ocotea, Persea, Cinchona, Eugenia,* and *Psidium.*

The great central pasture lands, called "llanos," occupy approximately one-half of the country. They consist chiefly of a grassy plain which in many places at the outer borders is from 2000 to 7000 feet above sea level. The slope toward the main rivers is broken by successive mesas or tablelands which in some parts are covered with forests as already described. In a general way the true llanos contain little else than grasses and some palms, though the chaparral is rapidly encroaching in places. The "chaparro" and various species of *Mimosa,* the forerunners of forests, are prevailing features of the landscape in many portions of the Orinoco Basin.

The only region not included in the foregoing description is that above the timber line, consisting of the elevated, wind-swept "paramos" covered with grass and drought-resistant shrubby plants of no economic value. The total area of these "paramos" is too small to justify further consideration.

The forests of Venezuela are not being exploited to any great extent. A large majority of the people live in the cities and towns and are scarcely available for woods work, while those in the country districts are chiefly engaged in raising cattle or in growing coffee, cocoa, and

sugar cane, the chief agricultural crops. Nearly half of the population is confined to the Federal District of Caracas and the Provinces of Miranda, Aragua, Carabobo, and Lara, where available native timber is so scarce that large quantities of lumber, chiefly yellow pine, are imported from the United States. While there are extensive forests with a great variety of useful timbers in many of the remote regions of the Republic, they are at present inaccessible pending the development of adequate transportation facilities.

The forest resources of Venezuelan Guiana are little known and will remain untouched for many years. Those in the densely populated provinces have been depleted to a large extent by squatters who periodically cut down and burn the best forests in their nomadic habit of locating on new land every few years. The States of Zulia and Trujillo in the Maracaibo Lake region include at present the most accessible forests, and logging is one of the chief pursuits there during the winter months, January to April, when the ground is sufficiently dry to permit hauling to the river banks. The Districts of Colon, Bolivar, Miranda, Sucie, Urdaneta, and Palz are rich in valuable timber which is rendered accessible by the numerous rivers and smaller navigable streams emptying into Lake Maracaibo. The logs are transported by water to Maracaibo, the chief export market for woods, and the principal kinds are "vera," boxwood, "curarire" (*Prosopis* sp.), brown ebony or partridge, and "roble colorado." Occasional small lots of fustic and brazilette are also shipped from this port, but the dyewood industry has never been large. The total for all timbers is between 5000 and 7000 tons annually, and, as the entrance to Lake Maracaibo is too shallow for ocean-going steamers, most of these exports are sent by vessels of light draft to Curaçao, Dutch West Indies, for transshipment to the United States and, to a lesser extent, to Europe.

Among other products of the Venezuelan forest may be mentioned "divi-divi," mangrove bark, tonca beans, rubber, chicle, balata, amyris wood, angostura bark, and balsam of copaiba. The last mentioned is extracted from the trunks of the *Copaifera officinalis* L. and related species, and is locally known as "accite," "cabima," or "camimba." The annual export of this balsam is valued at about $50,000. The trade in "divi-divi" pods amounts to about 10,000 tons every year.

BRITISH GUIANA

British Guiana, or Demerara, westernmost and largest of the three European Colonies, fronts upon the Atlantic Ocean for about 300 miles, and its area of approximately 89,500 square miles supports a popula-

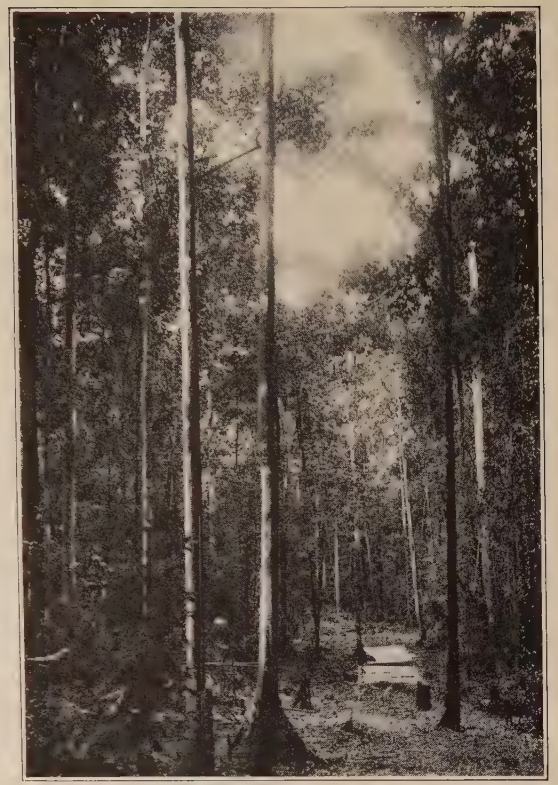


Photo by L. S. Hohenkerk.

In the British Guiana Forest.

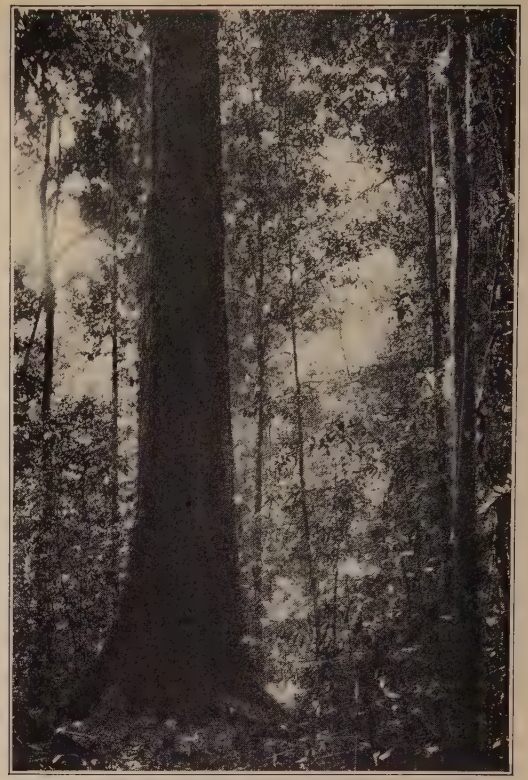


Photo by L. S. Hohenkerk.

Large Cedar Tree in British Guiana.

tion of nearly 300,000. More than a fourth of the inhabitants live in the city of Georgetown, situated at the mouth of the Demerara River. The Colony is well forested and many of the timbers have long been known in the English markets.

The country is roughly divisible into three topographic regions, namely, the coastal plain, the middle or slightly elevated belt, and the hinterlands. The coastal plain is from ten to forty miles wide and is, for the most part, low and flat; in fact, a large portion of it is below the level of high tide and must be drained artificially. This region is the scene of the greatest development and considerable areas have been cleared for growing rice, cotton, sugar cane, and other crops, though the total amount of land under cultivation amounts to less than one per cent of the Colony. The belt immediately south of the coastal region has a sandy clay soil and at one time its northern edge formed the beach. It is undulating or hilly, with elevations of from 50 to 200 feet, and is covered in places with a succession of sand dunes partially overgrown with a dense vegetation differing little from that of the Amazon selva. This forested shelf rises gradually southward until an elevation of several thousand feet is attained, and the whole aspect of the country changes with this increase in elevation.

The region surrounding the Pacaraima Mountains, in which the Potaro River has its source, is covered with a bushy deciduous growth gradually giving way to grassy savannas so common in the hinterlands. The irregularly disposed mountains and isolated bluffs are often 5000 feet high and some of the Pacaraima ridges are 8000 feet. Comparatively little definite information is available regarding the topography of the hinterlands or the true sources of the various rivers that are said to rise there. The Essequibo presumably has its source at the foot of Mount Yiniko in the Sierra Acarai, and the New River, which becomes the Corentyn farther north, heads in the same range. The Mazaruni, a tributary of the Essequibo, has its source in the Guiana Highlands of Venezuela. The Demerara and the Berbice drain the country between the Essequibo and the Corentyn. All of these rivers are navigable for considerable distances up to the first rapids.

The forests of British Guiana exhibit a wide range of variation and during recent years have suffered considerable modification through human agencies. The coastal plain, being within the influence of the equatorial rainfall, never suffers from protracted drought. Originally the entire area, except for occasional isolated savannas, was covered with a dense forest jungle, but much of it has been cleared for cane-growing.

To the south of this maritime belt all the river valleys are densely

timbered with many important lumber-yielding species of which the best known kinds are crabwood and mora. On the moist slopes are a number of other valuable species such as greenheart, purpleheart, brownheart, "kakaralli," and silver bally, while on the ridges the wallaba predominates. The eastern portion of the Colony is well wooded, but to the west and south it grades into a chaparral-like growth suggesting the "matorrales" in parts of Venezuela. Farther south this type is succeeded by extensive savannas with palms and occasional evergreen hardwoods to break the monotony. Approximately 15,000 square miles in the hinterlands are savannas, part of which lies within the Amazon Basin.

The interior plateau has an altitude of about 6000 feet and is well watered. Along all the streams and also on the upper slopes of the hills are belts of forests which merge at their upper and lower limits into extensive thickets. In general the growth is stunted and represents a transition between the dense rain forests to the north and west and the savanna in the territory drained by the Rio Branco. Dense forests are said to occur along the upper course of the Essequibo, but there is no published account of their character and composition. The southern region is elevated and it may be assumed from conditions known to prevail farther west that the ridges of the mountains near the Brazilian frontier are not forested, and that extensive savannas occur also at lower elevations. In the absence of more specific information it is not possible even to approximate the forested area of the Colony.

The forest resources of British Guiana have attracted much attention and some of the timbers are well known. Their extensive exploitation is seriously hindered, however, by the difficulty of access to the interior. There are no railroads in this region and the rivers are navigable only to the rapids just above tidewater. Consequently, in spite of her great timber wealth, the Colony imports from the United States over $300,000 worth of lumber and lumber manufactures annually.

The best known export timbers are greenheart, mora, crabwood, wallaba, and bullet wood. Greenheart has been used for more than a century in England, France, and Holland, and is unsurpassed in durability in wharf, ship, and dock construction. Wallaba is highly esteemed for shingles and large numbers of them are exported to the West Indies. Mora and crabwood are in local demand for general construction and for furniture, and some of the crabwood is exported occasionally as a mahogany substitute. Bullet wood is a very strong and durable timber, while the living tree yields balata gum, of which approximately two million pounds are exported annually. Various oils and resins, such as copal, gum elemi, and copaiba balsam, are also articles of export.

DUTCH GUIANA

Dutch Guiana, or Surinam, has a seacoast of 200 miles and a total area of approximately 41,000 square miles. The population of 108,000 is confined mostly to the coastal plains, and nearly a fourth of the people live in the capital city, Paramaribo, located on the Surinam River, 18 miles from its mouth. The country is well timbered.

The entire coast is fringed with mangrove swamps which present a natural barrier to the encroachment of the sea. Back of them the land is so low and flat that artificial drainage is necessary before agricultural crops can be grown. The average width of the coastal belt is ten miles and only a comparatively small portion has been cleared for cultivation. The forest is composed of a great variety of species, chief of which are the crabwood, cedar, "salie," possum wood, West Indian locust, "manbarklak," "basra locus," and mora. On some of the slight elevations along the coast are almost pure stands of possum wood trees which are large and well formed, some of them gigantic.

Farther inland the country is hilly and sparsely inhabited by the so-called bush negroes, the descendents of runaway slaves of the early days. They are engaged in agriculture in a small way, but their principal source of income is from the sale of logs which they transport down the rivers to Paramaribo. Some of the negroes make a specialty of gathering letterwood and search the forest for large trees yielding sticks of highly figured heart. There are only a few estates owned and managed by white people, and much of the territory remains unexplored.

The hinterlands are characterized by hills and low mountains which form the watershed between the rivers. The moist trade winds from the ocean keep the entire region well watered the year round, and over most of it conditions are favorable for forests. The savannas, so prominent a feature in British Guiana, are here reduced to small scattered areas. The Colony has a great wealth of timber which cannot be exploited until better transportation facilities have been developed.

Dutch Guiana exports timber to Holland, Belgium, Germany, United States, and the West Indies, and, unlike most of the other tropical American countries, supplies all the lumber needed for home consumption. The timbers are much the same as those of British Guiana, a notable exception being greenheart which, while present, is apparently too scarce to be commercially important. The so-called Surinam greenheart or bethabara, well known to manufacturers of fishing rods, is an entirely different wood and of a class with the "pui" of Trinidad and the "ipé" of Brazil. Mora is common in the lowlands and supplies large quantities of hard and durable timber for local use and for export.

"Manbarklak" and "basra locus" are promising woods for piling, because of their resistance to the attacks of shipworms. Crabwood occurs in nearly pure stands in the western part of the Colony and supplies excellent material for general construction as well as for more exacting uses, such as furniture and interior trim. Cedar is available only in limited quantities and the local demand for it is always greater than the supply. Possum wood (*Hura crepitans* L.) has recently been introduced in the American market under the trade name of "rakuda." Among the forest products other than timber may be mentioned balata, rubber, various oil seeds and nuts, and medicinal barks.

FRENCH GUIANA

French Guiana, or Cayenne, has a coast line of about 200 miles and an area of 32,000 square miles. Of a population of approximately 30,000, nearly one-half is confined to the city of St. Louis (Cayenne), situated on the Island of Cayenne. In fact, the only well-populated portions of the Colony are the low islands just off the coast of the mainland, where the Government maintains large penal institutions.

Unlike British Guiana and Surinam, French Guiana has no well-defined coastal plain, the narrow fringe of mangrove being swampy and unproductive. Immediately back of this strip are low hills which nowhere attain a height of 1500 feet, except in the far interior where the Tumuchumac range reaches a maximum at one point of 4000 feet. The rivers are not long and are characterized by numerous small rapids which render them useless for rafting out logs.

The forests on the uplands are poorly developed and there are many places in the interior that are almost bare. The better forests are, for the most part, restricted to the river valleys, the best timber being found along the Maroni River which forms the western boundary. The trees are much the same as those in the west of the Guiana region, but they contribute only small amounts of timber for local consumption or for export. The bulk of the wood now cut for local uses is for the manufacture of charcoal. The wood of a lauraceaous tree, "bois de rose femelle," is distilled in considerable quantities and the oil is used in the perfume industry. Some of this wood is of Brazilian origin and enters through the town of Oyapok. A wood well known to French furniture-makers is the "satiné," of which there appear to be two kinds, namely, the "satiné rouge," which is probably a legume, and the "satiné rubanné," which is the same as, or closely related to, the "muirapiranga" of the Amazon and said to be *Brosimum paraense* Huber. Some attempts are being made to develop a foreign trade in "simarouba," "carapa," and "angelique."

Photo by W. L. Kann.

In the Possum Wood Forest of Surinam.

Photo by H. C. Kluge.

Surinam Logs Brought out by Bush Negroes.

ECUADOR

Ecuador, next to the smallest of the South American Republics, occupies a triangular area south of Colombia and has a Pacific coast line of about 500 miles. The north and the south boundary lines are still in dispute and, consequently, the total area is variously estimated between 118,000 and 270,000 square miles. The population is considerably less than two millions.

The three great natural divisions of the country are the coast or littoral region, the upland or Andean region, and the Amazon or trans-Andean region. The coastal belt is scarcely twenty miles wide along the Gulf of Guayaquil in the south, but it widens out toward the north, particularly in the valley of the Esmeraldas where the best agricultural land is located. Even at its narrowest portions it exhibits a remarkable variety of soil and climatic conditions which are reflected in the vegetation. Mangrove swamps, called "manglares," a mile or more in width, fringe the shore and follow the rivers inland for long distances. Just back of the mangroves are the savannas or "tembladeras," which are relatively dry grazing lands one to three miles wide. Between the savannas and the foot of the Andes is an area now under cultivation but which formerly was covered with forests. In the foothills up to an elevation of about 4000 feet, the limit of tropical vegetation, is a zone still in its virgin condition and in parts heavily forested.

The Andean region is a high plateau continuous with that already referred to in Colombia. It is from twenty to forty miles wide at the top and is rimmed by two parallel ridges known as the Eastern and the Western Cordilleras. Numerous transverse ranges divide the plateau into elevated basins or mountain parks having an elevation of from 7500 to 9000 feet. The great ranges have an average height of 11,000 to 12,000 feet and there are over 100 peaks of 15,000 feet or more, about half of them volcanoes. This region has been referred to as the "Switzerland of America." The outer slopes of the two Cordilleras are densely forested up to the timber line, but the inner slopes and the interior basins are practically treeless.

The Eastern or Royal Cordillera has a steep slope to the east and the portions below 10,000 feet are clothed with true rain forests which continue practically unbroken to the level grassy lands in the Amazon Basin. This vast area is unexplored and its great timber wealth will await the needs of future generations. The range in altitude gives rise to a great diversity of tree species, both temperate and tropical, with useful woods of every description.

Ecuador has sufficient timber accessible to supply all local require-

ments and limited quantities are shipped to Peru. The forests of the western slopes are of great potential value, but suitable roads and railroads will have to be constructed before they can be exploited. When clearings are made in this region for coffee and cocoa plantations, little or no attempt is made to save the logs, even of the most useful kinds, because of the difficulties of getting the material to market. The principal timbers are "roble," "guachapelin," "balsamo," cedar, "maría," "huarango," and "pinuelo," while those of less importance include "saffron," "laurel negro," "cascol," "guayacan," "guayaba," "mangle," and "canelo." The timber most highly esteemed is the cedar. "María" is the chief timber tree on the lower slopes, while along the coast the mangrove is the only kind available in quantity; it is much used in general construction. In the south around Guayaquil the country is almost arid and timber is scarce. The only timber exported to the United States is the balsa, the lightest commercial wood known.

Over two million pounds of ivory nuts are exported annually to the United States for the manufacture of buttons. These nuts are the seeds of a palm (*Phytelephas macrocarpa* R. & P.), which grows throughout the foothills to an altitude of about 2000 feet. They are gathered by the natives and transported on pack burros to collecting points along the rivers and thence by boat to the seacoast for export. Another industry dependent upon the forest for its raw material is the manufacture of hats from the fiber of a palm-like plant (*Carludovica palmata* R. & P.), locally known as "toquilla," which grows in the low humid regions along the coast. These "sombreros de paja toquilla" are known to the foreign trade as "Panama" hats because they were formerly transshipped at Panama City.

The principal seaport of Ecuador is Guayaquil in the Gulf of Guayaquil. To the north of Cape San Lorenzo are a few less important seaport towns, including Manta and Esmeraldas, where steamers make regular calls. The chief exports from these points are ivory nuts, coffee, cocoa, and hides.

PERU

Peru has a Pacific coast line of approximately 1200 miles, or almost the entire distance between the equator and the Tropic of Capricorn. Portions of the boundaries are still in dispute, but the area claimed is about 722,500 square miles. In 1913 the Peruvian government estimated the population to be approximately five millions.

The same general topographic divisions obtain here as in the countries farther north, namely, the coastal region, the Andean region, and the trans-Andean or "montaño." The coastal plain has a maximum

width of about sixty miles and comprises about 10 per cent of the area of the Republic. It is largely desert and barren except in the neighborhood of the streams supplying water for irrigation. Tropical and sub-tropical crops are grown on the irrigated areas and there are many kinds of exotic trees such as the olive, mesquite, tamarind, eucalypts, and *Casuarina*. The capital city and the more important towns are located within this zone. Back of this is a narrow strip of foothills, on the lower part of which are plantations of cocoa, coffee, and fiber plants. The upper portions have a temperate climate and abundant rainfall and are clothed with forests of deciduous trees; the valleys are well adapted for agriculture.

The Andean plateau is a vast mountain mass comprising a fourth of the Republic. Its mean elevation is between 11,000 and 12,000 feet. Bordering it are the Eastern and the Western Cordilleras and between these ramparts are transverse minor ranges which divide the region into elevated basins as in Ecuador. The main basin lies in the south and includes Lake Titicaca which is 360 miles long and 100 miles wide; its elevation of 12,500 feet makes it the highest body of water in the world. Some of the peaks exceed 20,000 feet and a few in the Western Cordillera are active volcanoes. This entire elevated region is devoid of tree growth. Along the river courses draining the northern half of the plateau trees occur in the deep ravines which are far below the general elevation of the country.

The eastern slope of the Andes proper is marked by a treeless belt above the 10,000-foot contour, while below it is a series of hills and valleys that are heavily timbered with deciduous trees which in form and character compare favorably with those on the western slopes. There is an intermingling of species due to the presence of a number of depressions across the Andean Highlands which afford easy passage between the different vegetative zones. The lowest depression is near the Peru-Ecuador boundary and is only about 6500 feet above sea level. Below 5000 feet are the tropical or rain forests, called "mantaño," covering nearly two-thirds of the Republic and comprising a vast region that is mostly unexplored. It is drained by the Ucayali and the numerous tributaries of the Jarua, Purus, and Madre de Dios, all of which flow into the Amazon.

While this eastern slope is all included in the "mantaño" or "region of woods," there are great desert areas within its boundaries. Title to much of this region claimed by Peru is disputed by Bolivia on the east and south and by Ecuador and Brazil on the north and east. The forests around Iquitos are heavier than farther south along the Madre de Dios, where extensive areas of swamp, grass, and pure palm are found. These

swamp lands increase southward and thousands of square miles are permanently under water.

The lumbering industry is at present confined to the region about Iquitos on the Marañon River. Cutting is limited to timbers of light weight which can be floated down to Iquitos for local consumption. The native lumber available is not highly esteemed and is considered unsuited for making the boxes in which rubber is exported, consequently the bulk of the lumber consumed in the cities is imported from the United States. Timber on the eastern slopes cannot be transported over the Andes, though occasional small lots, including mahogany, are sent down the Amazon for export.

The chief forest products of commerce are "tagua" or ivory nuts and rubber. Most of the ivory nuts come from the foothills in the north and upward of three million pounds are exported annually. Rubber is gathered in the "mantaño" and either shipped down the tributaries of the Amazon to Manaos and Pará, Brazil, or transported on pack burros across the Andes to Payta, Callao, and other seaports. The industry is of much less importance than formerly. "Coca" (not to be confused with cocoa), the source of the alkaloid cocaine, is obtained from the leaves of *Erythroxylon Coca* Lam., a forest tree now grown in plantations on the west slopes of the coast ranges between 3500 and 7000 feet elevation. Some of the product is exported to Europe and America, but the bulk of it is consumed locally. Cinchona bark and sarsaparilla were formerly important forest products, but are now of little value.

BOLIVIA

Bolivia, third in size of the South American Republics, is one of the two countries without a seacoast. Portions of its boundaries are in dispute, but it is credited with an area of approximately 514,000 square miles and a population of two and a quarter millions.

The topographic features are well defined. The sierra district embraces that portion of the country between the Andes proper or Cordillera Real on the east and the Cordillera Occidental on the west. The high Bolivian tableland, the Alta Planicie Central, covers over 65,000 square miles and has an average elevation of 12,000 feet, being the largest elevated plateau in the world with the exception of Thibet. The Desaguadero River, draining Lake Titicaca to the north, flows southward for 250 miles into Lake Poopo, beyond which are extensive swamps.

The Andes proper have an average elevation of about 20,000 feet and are perpetually covered with ice and snow. The highest peak, Illampu

or Sorata, is said to be 25,000 feet high, and there are several others nearly as high. The numerous transverse ranges form valleys noted for the fertility of their soil and supporting the bulk of the population. During the wet season, December to March, corn and other crops are grown, but the dry season is too severe and prolonged to permit the growth of trees except on the few places now under irrigation.

Both the inner and outer slopes of the marginal ranges are bleak and bare above 10,000 feet, but just below this level are hardy grasses and shrubs. Descending further these gradually give place to trees which form deciduous forests at about 7500 feet and these in turn merge into the tropical forests at 5000 feet. These tropical forests cover the lower eastern slopes of the Andes proper and the numerous spurs extending eastward into Brazil.

The region lying east of the plateau comprises about 90 per cent of the entire Republic, and three-fourths of it is drained by the Madeira, the largest of the Amazon tributaries. Many rivers have their source in the upper slopes of the Andes and in the extensive "region of the woods" here known as the Yungas. Not all of the area is forested, as most vegetation maps indicate. In the Province of Beni to the east of the Beni River is a great prairie inhabited chiefly by Indians; north and east of Trinidad are savannas known as Llanos de Mojos; and farther to the east and the south the Llanos Guarayos and Chiquitos interrupt the continuity of the forests. The other quarter of the Bolivian Yungas is within the Paraguay drainage basin. The Paraguay River forms the eastern boundary, while the Pilcomayo drains the Yungas in the west as far as Sucre. These two rivers flow together at Asunçion and between their northern courses is the territory of the Gran Chaco including the Llanos de Manzo. The Bolivian Chaco is a low-lying expanse of permanently wet or periodically inundated llanos palm-dotted or sparsely forested with hardwood trees in decided contrast with the true Yungas and the impenetrable growth along the rivers draining into the Madeira. During the dry season portions of the Chaco are subjected to prolonged parching and the soil becomes strongly alkaline and suggests the names of places such as Salina de San Jose and Salina de Santiago.

There are many palms in the Chaco region, the most important being the wax palm. Some of the hardwood trees, though scattered, produce good timber, but only a few are being used commercially at present. Among these are the "nuatipuna" (*Xylosma venosum* N. E. Brown), "guayacan" (*Caesalpinia melanocarpa* Gris.), "algarrobo" or mesquite (*Prosopis juliflora* DC.), "vinal" (*P. ruscifolia* Gris.), "timbo blanco" (*Pithecolobium multiflorum* Benth.), quebracho (*Schinopsis* sp.), and

various species of *Coccoloba*, *Nectandra*, *Tecoma*, and *Croton*. "Algarrobo" is the most used wood for all sorts of local purposes. The quebracho is little exploited.

Since only a small part of the population lives in the forested parts of Bolivia, comparatively little lumber is manufactured and most of that by primitive methods. The lumber requirements of the centers of population on the highlands are supplied by imports direct from the United States or by merchants in Chilean seaport towns having railroad shipping facilities to the interior. Portions of the forest are being destroyed to clear the land for agriculture on the eastern slopes of the Andes between elevations of 3000 and 7000 feet, but otherwise the timberlands of Bolivia remain almost untouched. The principal forest products of commerce are rubber, cinchona, and "coca."

CHILE

Chile, extending from Peru to the extreme southern end of the continent, has a Pacific coast line little short of 3000 miles and an average width of about 100 miles, giving it a total area of about 300,000 square miles. The population is approximately four millions.

The geographical features of the Republic are unique in that the country stretches along the west coast of the continent from the region of Atacama in the extreme north to the well-timbered mountains and icy peaks in the south. The first 650 miles in the north are mostly desert; the next 350 miles are slightly less arid and are valuable for mineral deposits; thence for about 850 miles are fertile agricultural lands, beyond which for more than 1000 miles is a vast district of islands and uplands rich in forests and grazing lands.

The vegetation of Chile is more or less isolated by reason of the barriers which surround it. On the north is a vast desert that is practically bare; to the east are the high Andes which do not permit the passage of species from regions beyond; to the west is the sea. As a result Chile has a large number of species that are not found elsewhere in the world, though showing many affinities to the vegetation of New Zealand. Owing to the peculiar climatic conditions in the north of the Republic there are no indigenous trees either in the valleys or to the north of Valparaiso. Many exotics, such as the olive, carob, walnut, eucalypts, Australian pine (*Casuarina*), chestnut, and poplars, have been planted more or less extensively where the land is irrigated.

When the Spaniards first visited Chile the forests extended northward to Santiago, which marks the southern limit of the semi-arid conditions

where the brush land gives way to true forest growth. Between Santiago and Concepçion is a great agricultural section, where the forest has been exploited for many years. The true forests of today may be said to lie south of the Bio Bio River in latitude 36° 49′ south.

Although the forest flora of Chile is better known than in any other South American country, no actual forest survey has been made and the rough estimates of the timbered areas vary from forty to fifty million acres. There are probably more than 200 sawmills each with an average annual cut of a million board feet of lumber, but their operations are very largely confined to timber removed in clearing agricultural land. Such soils support a very dense growth with the larger trees in a hopeless tangle of climbing vines, and it has therefore become the practice to cut the vines and underbrush at the beginning of the winter season and later burn over the forest to facilitate logging. The upland and especially the coniferous forests are more open and are accordingly adapted to the logging methods common in the United States. South of Valdivia is a vast forested region of which little information is available.

The Chilean forests are within the South Temperate Zone and strictly do not fall within the scope of this work. Consequently they are not considered in detail and only a few woods are described. For convenience, however, the principal timber trees are listed as follows:

(1) *Coniferae*	
Mani, mañiu, or mahiu	*Podocarpus chiliana* Rich.
Llengue	*Podocarpus andina* Poepp. & Endl.
Pino piñon, or pehuen	*Araucaria imbricata* Pav.
Alerce	*Fitzroya patagonica* Hook. f.
Cipres	*Libocedrus chiliensis* Endl.
Cipres	*Libocedrus tetragona* Endl.
(2) *Eucryphiaceae*	
Ulmo	*Eucryphia cordifolia* Cav.
(3) *Fagaceae*	
Roble de Magellanos	*Nothofagus antarctica* Forst. f.
Roble coyan, pellin, or hualle	*Nothofagus obliqua* Mirb.
Rauli	*Nothofagus procera* Poepp. & Endl.
Coigüe	*Nothofagus Dombeyi* Mirb.
(4) *Lauraceae*	
Bellota	*Bellota Miersii* C. Gay.
Peumo	*Cryptocarya Peumus* Nees.
Lingue	*Persea Lingue* Nees.
(5) *Magnoliaceae*	
Canelo	*Drimys Winteri* Forst.

(6) *Monimiaceae*	
Boldo	*Peumus Boldus* Molina.
Laurel	*Laurelia aromatica* Juss.
(7) *Myrtaceae*	
Luma	*Myrtus Luma* Barn.
(8) *Proteaceae*	
Avellano	*Guevina Avellana* Molina.
Radal	*Lomatia obliqua* R. Br.
(9) *Rosaceae*	
Quillai	*Quillaja Saponaria* Molina.

ARGENTINA

Argentina, second in size of the South American countries, is separated from Chile on the west by the Andes Mountains which form a natural boundary for 3000 miles. Its Atlantic coast line extends from the estuary of the River Plate to Tierra del Fuego, a distance of 1600 miles. Its area of approximately 1,150,000 square miles supports a population of over eight millions.

The physical features fall more or less clearly into four main divisions, namely, the Andean, the Gran Chaco, the Pampa, and Patagonia. The Andean includes the eastern slopes of the main cordillera with its innumerable ramifications, plateaus, and valleys. It begins with the Cerro de las Granados which forms a part of the boundary between Bolivia and Argentina and extends along the western frontier southward to the Straits of Magellan. In general, the entire region is excessively dry and swept by furious winds that blow incessantly, so that the growth of trees is made practically impossible. Moreover, in some of the valleys of the north the alternation of the intense heat of the day with extreme cold at night inhibits the development of forests.

The northwestern part of the Republic, embracing the provinces of Catamarca, Jujuy, Salta, and Tucuman, consists of highlands traversed by numerous spurs of the Andes with high snow-capped peaks. Between the high ridges are elevated tablelands, called "puñas," which are for the most part bare of vegetation and abound in lakes and in waste land classified as swamps or saline deposits, where the soil is arid, sterile, and improperly drained. A number of the smaller streams heading on the upper slopes of the snow-capped mountains become lost in these desert areas so common on the high dry wind-swept plateaus. At somewhat lower levels and between the mountain ranges where sufficient rainfall occurs or where water is available for irrigation, agricultural crops are grown and high forests occur. Here the vegetation is of a tropical or sub-tropical character and some of the forests contain ele-

Photo by H. M. Curran.

In the Forest of Misiones, Argentina.

Photo by H. M. Curran.

Edge of Forest in Alta Paraná, Argentina.

PLATE XV

ments of the Amazon as well as of the Chaco country to the east. Tucuman has extensive grasslands and in the eastern part the forest consists primarily of an open growth of quebracho, "cebil," and "aliso" (*Alnus* sp.), with other less important species.

To the east of the highlands of Jujuy, Salta, Tucuman, and Catamarca is the famous Chaco country which is continuous with that of Bolivia, previously mentioned, and extends into Brazil and over the western half of Paraguay. In Argentina it includes the slightly undulating plain lying between the Pilcomayo and Paraná on the north and east and the Salado on the west. A large part of the Chaco has never been explored, at least no records of any explorations are available, but in a general way it may be said that the northern portion is covered with open forests, including species common to the Amazon region, while the remainder is a mixed forest with a predominating semi-desert vegetation consisting largely of thorny shrubs and palms. Considerable areas are permanently under water, especially along the Paraguay River. Immediately back of these swamplands are alternating grasslands and luxuriant tropical forests in which "cebil" and "quebracho colorado" form the principal species, especially to the west of the Juramento River. In locations where the soil is moderately fertile the "tipa," "laurel" (*Nectandra porphyria* Gris.), walnut, cedar, and various species of *Eugenia* abound. Groves of palms characterize a very large part of the Chaco country and the true hardwood forests, although covering vast areas, are confined chiefly to the proximity of streams, especially in the province of Formosa.

South of the Chaco country is a region embracing the provinces of Corrientes and Entre Rios, which has extensive forested areas known as "payubre" in Corrientes and "selva de Montiel" in Entre Rios. The forested area known as Mesopotamia comprises about a fifth of the two provinces, the remainder consisting of swamps or upland open pasture and agricultural land.

South of Salado River and as far as the Colorado is the Pampa proper, an extensive plain of dry land and salt marshes practically devoid of trees except occasional "ombu." This prairie country, especially near the coast where rainfall is greater than in the interior, is valuable for cattle-raising. Along the foothills of the Andes is the so-called "monte," a zone of low thorny trees or shrubs mostly species of *Mimosa, Prosopis, Lithraea, Schinus, Larrea, Condalia,* and *Zizyphus.* A very considerable change in the Pampa region has been brought about since the advent of European civilization by the introduction of many new plants from all parts of the world. Not only have many farm and garden plants been introduced, but many exotic trees, such as *Eucalyp-*

tus, Casuarina, Melia, Populus, and *Prosopis,* are now grown in all localities for windbreaks, shade, shelter, fuel, and lumber.

Patagonia comprises the territory south of the Colorado and includes the provinces of Neuquen, Rio Negro, Shubet, Santo Cruz, and Tierra del Fuego. The tablelands in the interior are masses of mere rocks or boulders alternating with depressions growing grass and shrubs and useful only for grazing. The true forests are in the inaccessible locations in the far interior as already described, and extend from southern Neuquen along the foothills of the Andes for 1000 miles to the Tierra del Fuego. They are of much the same composition as those of southern Chile and being without the tropics do not come within the scope of this work.

Forest industries have not been extensively developed in Argentina, because of the lack of sufficient accessible timber. In the north where true forests occur much of the land is swampy and the transportation of logs to the rivers is at present a formidable undertaking. As a rule the commercial trees are too scattered to warrant the employment of modern machinery and the operations as now conducted are so expensive that it has been found more economical to import lumber. More American lumber is consumed in Buenos Aires than in all the rest of South America combined.

Quebracho, the well-known tanwood, is the basis of the only forest industry of note in Argentina and is confined to several provinces in the northeast. Formerly only the wood was exported but manufacturing plants were subsequently established for the production of extract for local use and for export. Most of the quebracho entering the United States, however, does not originate in Argentina. Quebracho wood is much used locally for fuel, railway ties, and various kinds of durable and heavy construction.

The "algarroba" or mesquite is a highly useful wood in many parts of Argentina, being employed for railroad ties, paving blocks, and for dyes. It produces a color substance similar to that of fustic and it is said that during the war quantities of both roots and stems were shipped to Italy for use in dying cloth for uniforms. Other locally useful timbers are cedar, "lapacho," "timbo," "urunday," fustic, "quebracho blanco," "curupay," and "palo rosa."

PARAGUAY

Paraguay, like Bolivia, is an inland Republic. Although portions of its northern boundary have not been definitely fixed, the approximate area is 175,000 square miles and the population is less than one million.

The Paraguay River north of Asunçion divides the country into two

nearly equal parts. To the east is Paraguay proper, which may be considered a continuation of the highlands of Brazil; to the west is the Gran Chaco which is, for the most part, low and level. Paraguay proper is essentially a vast stretch of dense tropical or sub-tropical forests alternating with cleared areas, grasslands, and elevated portions (not over 2000 feet) where the chief trees are "pindo" and "mbocaya" (*Cocus*). The true hardwood forest is characterized by immense trees of value amid a tangle of vines and bush rope.

Along the Paraguay River is a monotony of grasslands broken only occasionally by clumps of trees. The bulk of the population and the two principal cities, Asunçion and Concepçion, are located in this fluvial zone. At slightly higher elevations the homesteads become less numerous and the slopes of the hills are clothed with a very dense vegetation. The "yerba mate," Paraná pine, and certain leguminous trees become more abundant eastward, while certain other species, such as the "tala," disappear entirely. The families most abundantly represented in this forest are the Leguminosae, Anacardiaceae, Euphorbiaceae, Rutaceae, Myrtaceae, Bignoniaceae, and Moraceae.

Eastern Paraguay receives abundant rainfall and the streams are numerous. The forests compare favorably, at least in part, with the true rain forests. In the favorable situations are such trees as "urunday," "ayunandy" (*Persea* sp.), "ñandipa," "tatayba" or fustic, "quina quina," and "timbo." Where the soil is thin and less retentive of moisture the forest is composed of various species of *Piptadenia, Acacia, Prosopis, Tecoma, Bulnesia, Croton, Erythroxylum, Cedrela, Hymenaea,* and *Psidium.* Citrus trees are of general occurrence and the guavas are common in the cleared areas where they are associated with different kinds of "algarroba." The "quebracho blanco" occurs in the Misiones district where the Paraná River turns eastward. "Quebracho colorado" is found along the banks of the Tibicuary River and supplies the principal construction timber of that region. Another important tree is the Paraná pine, locally known by the Guaram Indian name of "curi-y." There are several kinds of silk-cotton trees with massive trunks and with fruit pods filled with vegetable wool useful for stuffing pillows and mattresses. The leaves and fruits of the citrus trees are collected extensively and used in preparing the "petit grain" of commerce. The leaves of the "yerba mate," a kind of holly locally known as "caa," supply the Paraguay tea. This bush or small tree thrives best in the eastern district and all along the Sierra Amanbay and Maracayu and on the central Paraná.

In the western part of Paraguay or El Chaco the country is low and poorly drained, with swamps alternating with slightly elevated dry

waste lands thickly overgrown in part with a tangle of low bushy vegetation. Much of the region resembles a heath, but in places there are clumps of palms and in others groves of "quebracho colorado." Much of the Chaco has not been fully explored, partly because of the difficulty of travel and partly because of the unfriendliness of the Chaco Indians, so that the actual extent of the forests is yet to be determined.

Along the lower courses of the rivers draining into the Paraguay and the Pilcomayo are broad fringes of forests with a great variety of species. Further to the north and west there are vast stretches of grassland suitable only for grazing purposes and broken here and there with groves of trees where the soil conditions are favorable. There are none of the artificially planted trees such as are so common in parts of the Argentine Pampa.

About half of Paraguay is forested, principally the eastern and northern portions. In the northeast there are almost unbroken forests, thousands of square miles in extent, and numerous rivers well adapted for transporting logs to the consuming centers. Large quantities of squared cedar logs are rafted to Concepçion and Asunçion and shipped in large steamers down the Paraná River, chiefly to Argentina. Other woods now being exploited for home consumption and also for export are "palo blanco" (*Bombax*), "curapay," "lapacho," "ivivaroa" (*Ruprechtia*), and "quebracho colorado." The quebracho industry is very important in the Chaco and the value of the logs exported exceeds $2,000,000 annually.

The annual crop of "yerba mate" in Paraguay is approximately 17,000,000 pounds, of which one-half is exported. From the great areas covered with citrus tree are obtained sweet fruits for food and bitter kinds for the manufacture of oxalic and citric acids and their compounds, while an oil known as essence of petit grain is distilled from the leaves and used as a base for perfumes. During a normal year the value of the exports of this oil exceed $100,000.

URUGUAY

Uruguay, smallest of the South American countries, has an Atlantic coast line of about 200 miles and an area of about 72,000 square miles. Of the total population of 1,400,000, about one-third live in Montevideo, the capital city.

Although there is considerable variation in the topography, the country generally is an undulating plain which may be considered a continuation of the Pampa district of Argentina. The northern portion, however, is broken by the southern spurs from the Brazilian Highlands.

Logging Quebracho in Argentine Chaco.

Photo by H. C. Kluge.

Average Size of Quebracho in Paraguay.

The southeastern section is rolling, with a few hills or low mountains of less than 2000 feet elevation. The southwest differs little from the Argentine province of Entre Rios and is characterized by low hills and many streams. The latter flow into the Rio Negro which rises in the mountains of southeastern Rio Grande del Sul and takes a westerly course entirely across the Republic.

The mountain ranges in the northern provinces, while not very high, are noted for their extreme rockiness and barren ridges. Because of the absence of tree growth all of the higher elevations stand out conspicuously, their fawn color in sharp contrast with the deep green of the fertile forest-clad valleys below. Erosion is excessive in the higher altitudes, but as one descends a wealth of shrubby growth appears, with rosemary, acacias, myrtles, mimosas, and scarlet-colored bauhinias in dense thickets over the stoniest hillsides. At still lower altitudes the areas of thin soil are replaced by rich accumulations which support true forests, especially along the Rio Negro near the Brazilian border.

Most of the timber is found in the northern third of the Republic and the native species are generally those of the warm temperate climate. It is estimated that forests cover about two out of the forty-five million acres of this region, or about one-twentieth of the area of the Republic, and that true agricultural lands comprise an equal amount. The remainder is best suited for grazing and is at present the great source of wealth of Uruguay. These proportions will gradually change, however, since some of the timbered areas along the streams will eventually be utilized for agriculture. There are millions of acres that should be afforested and substantial progress in this direction is now being made.

The southern half of Uruguay is essentially a succession of park-like grasslands interrupted by forest-fringed streams and by rounded elevations whose slopes are in part covered with chaparral, low crotons, and thorny acacia bushes. True forests rarely occur away from the Rio Negro and its branches, though numerous plantations have been established for shade or windbreak. In the most densely populated districts there are many orchards of apple, quince, pear, peach, cherry, fig, medlar, and olive.

The best known and most generally used wood grown in Uruguay is the "algarroba" or mesquite which supplies large quantities of posts and stakes for fencing and serves many other purposes, including fuel; in many sections remote from the forested belts along rivers it is the only wood available. The bulk of domestic timber is obtained in the north and sent down the Uruguay River to Montevideo. The principal kinds are cedar, "timbouva," "laurel," "lapacho," walnut, "tipa," white quebracho, "iriraru," "urunday," and Paraná pine. There is also a

certain amount of timber available from the plantations which include Nordmann fir, maple, alder, willow, poplar, pine, *Acacia melanoxylon* R. Br., *Ailanthus*, *Casuarina*, and *Eucalyptus*. By far the greater part of the lumber used in the centers of population is, however, derived from the United States and the imports for a normal year amount to about $2,000,000.

BRAZIL

Brazil, with an area of about 3,275,000 square miles, comprises about one-half of South America and borders on every other country on the continent except Chile. Its greatest length from north to south is about 2600 miles and its greatest width about 2500 miles. The population, approximately thirty millions, exceeds the combined population of all other South American countries. Brazil is divided into four natural regions, namely, the Guiana Highlands, the Amazon Basin, the Atlantic littoral, and the Brazilian Highlands. The Guiana Highlands include the irregular mountain mass which serves as a watershed between the Amazon tributaries and those of the Orinoco and other rivers flowing northward into the Atlantic. The Brazilian portion of this tableland embraces the whole of the southern slope which is a succession of irregular broad mesas or steps from 10,000 feet elevation down to sea level. The general trend of the main ridge and terraces is east and west, and the northern slopes, being exposed continually to the moisture-laden winds from the sea, are, for the most part, densely forested up to about 600 feet. On the southern slopes, where conditions are somewhat different, the middle altitudinal zone is covered with an open evergreen forest; just above this, where the rainfall is greater, there is a growth of deciduous trees, and at still higher elevations the forests become park-like and finally disappear. To the south and east of the foothills are more or less continuous rolling savannas or grassy woods with fringes of woodland along the water courses. To the east they merge into the catinga, a chaparral-like jungle growing under semi-desert conditions, in which the chief plant forms are thorny bushes, cacti, palms, and water-storing bombacaceous trees. Palms are a conspicuous feature in all forest types, particularly along the borders of low marshes. Other common plants in the catinga type are different species of *Caesalpinia*, *Roupala*, and *Swartzia*. Along the coast from the Oyapok to the Amazon River and for twenty to forty miles inland is a dense forest forming the connecting link between those of the Guianas and the Amazon selva.

The Amazon Basin is a vast territory limited by the Guiana Highlands on the north, the Andes on the west, and the Brazilian Highlands on the south and east. The total area drained by the Amazon has been esti-

mated to be about two and three-quarter million square miles, large parts of which belong to Colombia, Ecuador, Peru, and Bolivia. The Brazilian part is practically all below 600 feet elevation except on the western slopes of the Brazilian Highlands. The Amazon River system is the largest in the world; its gigantic tributaries, the Madeira, Xingú, and Tapajos from the south and west, and the Rio Negro from the north, drain regions that have been only partially explored. The forests along the lower Amazon and the Tocantins have been studied, but the accounts do not cover the elevated regions between the main tributaries farther to the west and away from the main channel of the Amazon. It is estimated that there are at least 2500 species of trees in this great basin, but the timbers are for the most part inaccessible at present and comparatively few of them probably will prove of much commercial value.

The Atlantic littoral extends from French Guiana to Uruguay, a distance of 4000 miles. It is indented by numerous estuaries and smaller or larger landlocked bays which are in part surrounded by the steep ledges of the precipitous eastern slopes of the Brazilian Highlands. This coastal plain between the foot of the highlands and the sandy beach is a narrow strip of land bearing tropical vegetation far beyond the Tropic of Capricorn; along the beach it consists of ill-nourished trees and shrubs growing in imperfectly drained soils. Mangrove skirts the coast wherever the land is sufficiently low for its development, covering vast areas in the north and also in São Paulo. This mangrove belt varies greatly in width and in many places completely disappears. Immediately back of it are low treeless savannas which are an almost exact replica of the "tembladeras" already noted in Ecuador. This unproductive area may be dry and barren, as in the region north of Pernambuco, or swampy, as in Espirito Santo and Rio Grande do Sul.

Beyond the evergreen littoral formation or savanna areas the true forests of the seaward slopes of the east Brazilian Highlands begin. The slopes south of Pernambuco are well watered the year round by the constant rain-bearing winds from the ocean. Here and there, the continuity of the ledges is interrupted by breaches extending back from the plain to the summit of the plateau carrying with them a flora, not unlike that of the Amazon Valley, which is preserved all along these slopes southward to Port Alegre. Palms predominate in the lower belt gradually giving way to the rich hardwood forests in which "peroba," brazilwood, and rosewood are important components. This latter type of forest occurs from Bahia southward to Santos and extends inland along the many rivers until it mingles with the upland vegetation in which vines and epiphytes are replaced by leathery-leaved shrubs. That portion of the belt from Bahia to Uruguay includes the true agricul-

tural land of Brazil, and extensive areas have been cleared for tropical agriculture. The upper slopes, where the forests are more nearly virgin, are being used to an increasing extent for growing sub-tropical crops. The region as a whole includes the present commercial and economic forests of Brazil.

Back from the maritime plain and south of the estuaries of the Amazon and Pará Rivers, the vast interior tableland (Brazilian Highlands) rises in successive steps, each 800 to 1000 feet high. The ledges are in many places almost sheer and from the ocean impress the observer as if they were high mountains. On its eastern slope numerous seaboard rivers rise and flow fanwise into the Atlantic. Though most of these are short, the São Francisco is a notable exception, since it drains the large interior plateau which from southern Minas Geraes slopes gently to the north for over 2000 miles. The western and northern part of the plateau is drained by the upper tributaries of the Tocantins. From southern Minas Geraes and São Paulo the plateau slopes southward and forms a part of the Rio de la Plata drainage system. Along the eastern edge is an interrupted ledge about 3000 feet high separating the upland from the narrow coastal plain. These highlands constitute the most conspicuous topographical feature of Brazil, and the rivers rising there water every state in the union except Amazonas.

THE FORESTS BY STATES

Owing to the vastness of the area of Brazil the forests and the conditions determining their character and distribution are considered by states beginning at the north. The northeast littoral states of Pará, Maranhão, Piauhy, Ceará, Rio Grande do Norte, and Parahyba front on the Atlantic and have a climate peculiar to the northeast district, where the year is divided sharply into the dry and the wet seasons. For six months or more each year it is very dry and the forests are confined to the coast and along the water courses. The littoral vegetation along the lower Amazon and the Tocantins extends southeastward along the coast even beyond Maranhão. The higher and better drained areas are more or less continuous savannas joining those of Pará between the coast and the Rio Tocantins.

The climatic and forest conditions in the coastal plain or in the Atlantic seaboard states south of Parahyba are somewhat different from those in the northeastern littoral states. The coast line extends in a southwestern direction and the entire region is well watered and there are no such pronounced wet and dry seasons.

Pará, the third largest of the Brazilian states, embraces the drainage system of the lower Amazon, including the lower Tocantins. Its coast

line is exceedingly irregular. The chief city is Belem, commonly known as Pará, which is situated on the south side of the estuary of the Pará River. Along the rivers and for some distance northward from the banks the true Amazon selva alternates with savanna lands, while on the more elevated areas there are open park-like forests alternating with savanna or catinga types. Great areas of grasslands occur throughout the delta region. Somewhat similar conditions are found to the south of the Amazon. The Rio Gurupy, separating Pará from Maranhão, marks the termination of the Amazon flora and the beginning of a semi-desert type which grades into a savanna or catinga formation so characteristic of the hinterlands of the five northeastern states Maranhão, Piauhy, Ceará, Rio Grande do Norte, and Parahyba.

The area to the west of the Tocantins and south of the Amazon is not well known and considerable areas have probably never been visited by white men. Both the Xingú and Tapajos are navigable, but there is little more than conjecture as to what lies beyond the fringes of the flood forests. That these rivers have their headwaters on the western slopes of the East Brazilian Highlands is evident, but just what the forest conditions are beyond the Amazon selvas has not been determined. The country is rolling and gradually rises in low terraces, each successive step exhibiting sparser vegetation. Beyond the true Amazonian forests palms predominate, eventually giving way to savannas with narrow belts of low tropical jungles along the water courses.

Maranhão lies to the south and east of Pará and is one of the most important states in north Brazil. Its coast line is indented by numerous estuaries and the coastal plain is low and flat; the interior, however, is broken and mountainous. The climate is good, owing to the trade winds from the northeast, and the country does not suffer from droughts as do the states to the south. The Rio Parnahyba forms its eastern boundary and is said to be 1400 miles long. The coastal plain is very fertile and has extensive high forests. The inland area between the Maranhão and Parahyba is high and dry, with extensive grass and bush lands. São Luiz, the chief city and the capital, is situated on the coast.

Piauhy has a very short seaboard, scarcely eighteen miles long, the greater part of which is occupied by the estuary of the Rio Parnahyba. The lowlands are entirely covered with mangrove forest, but farther inland these give way abruptly to savannas or to low scrubby growth and finally to a treeless region that is excessively dry during the rainless season.

Ceará borders on the Atlantic for 435 miles and is very arid. The immediate coastal strip is covered with a low and commercially unim-

portant forest which at higher altitudes grades into savannas too dry for agricultural purposes except under irrigation. The interior highlands give rise to numerous streams which are swollen mountain torrents during the rainy season and shrink to mere rivulets or run dry during the periodic droughts. The interior dry zone embraces also considerable parts of Piauhy, Rio Grande do Norte, and even the dry, scrubby growth of the hinterlands of Pernambuco and Bahia.

Rio Grande do Norte, with a sea coast nearly equal to that of Ceará, occupies the northeastern corner of Brazil. Cape São Roque marks the first land of South America sighted by Americus Vespucius in 1499. The coast is low and sandy with the usual littoral vegetation fringing the bays and estuaries. The interior is hot and the rainfall very irregular and as a result the country is arid except along the larger streams which are fringed with forests. The uplands are similar to those of Ceará.

Parahyba has about 100 miles of low and sandy coast. The interior valleys are fairly well watered and irrigation is possible over considerable areas. The uplands, however, are very dry and a large area in the western part of the state is included within the arid zone embracing parts of Rio Grande do Norte and other littoral states to the north.

Pernambuco has a coast line of 150 miles, characterized by extensive swamp lands with low mangrove formations. Farther inland are growths of palms and low forests, though high forests occur along the streams which drain the interior hills extending in a northeasterly direction from Bahia into Parahyba and Ceará. The wet and the dry seasons are still well marked in the interior and the vegetation near the western frontier resembles that already described for the upland dry regions of Ceará and Piauhy. The bulk of the lumber consumed in Recife (Pernambuco), the capital city, and other centers of population on the coast, is obtained from Pará.

Alagôas occupies a small triangular area just south of Pernambuco. It borders on the Atlantic for about 200 miles, and its southern boundary is the Rio São Francisco which is navigable for 200 miles. Only a small part extends inland beyond the foothills and, being well watered, more than half of the total area is covered with forests containing many important Amazon trees, such as the "vinhatico," "angico," cedar, rosewood, "jatoba," "louro," "peroba," "canella preta," and "massaranduba." Although the forests do not attain as great development of those in southern Bahia, they constitute an important asset to the state's wealth.

Photo by H. M. Curran.

Upper Slopes, Coastal Region of Southern Bahia, Brazil.

Photo by H. M. Curran.

Cut-over Lands, Coastal Region of Southern Bahia, Brazil.

Sergipe, smallest of the Brazilian states, lies between the São Francisco and the Rio Real with a seaboard of about 160 miles. The coast is low and hot and the usual tropical forests occur as far inland as the "sertão" or desert, where the growth is of a low bushy type. Less than one-half of the state is forested.

Bahia, one of the largest and most important states of Brazil, has a coast line of about 650 miles, with an excellent harbor at the city of Bahia (São Salvador). The coastal plain includes extensive swamp lands and just back of these the country becomes exceedingly undulating, and contains valuable forests. Those along the coast have a tropical aspect, but on the elevated slopes farther inland they change to a deciduous type and often the ridges are bare.

Although the greater part of Bahia may be classed as forested, there are extensive areas of rolling grasslands in the interior. The forests are park-like on the ridges and upper slopes facing the moist winds from the ocean, but the savanna type prevails over most of the rolling tableland. The northern portion is dry and the savanna lands alternate with low thickets consisting chiefly of thorny bushes and aloe-like plants, with numerous cacti, palms, and agaves, all of which are typical desert species. The "carnaúba" palm is an ever present feature of the interior landscape and often forms extensive groves around swamps. The best forests are mostly in river valleys and the larger size of the trees suggests the Amazon region. The more accessible of these forests have been culled of their best timber, but elsewhere they are largely untouched. Further information regarding this region will be found in the descriptions of the trees in the second part of this book. Back from the river banks the forest growth dwindles into the catinga type and gradually into the savanna or desert formation.

Espirito Santo follows the coast for 270 miles and is one of the most important of the littoral states. It is well watered by many streams rising mainly in Minas Geraes; the Rio Doce is the largest and most important. There are areas of swamplands, especially to the south of Campos, but beyond these the entire state is covered with forests which are not exceeded in quality by those of any part of Brazil. Lumbering operations are in progress on the Rio Doce, and logs and lumber of rosewood, "peroba," "oleo vermelho," cedar, and others are brought to Victoria by rail for shipment to Rio de Janeiro or for export. The state lies wholly within the seaward slope and receives the benefit of the moist trade winds which assure abundant rainfall throughout the year, consequently this portion of the coastal forest belt is exceptionally well suited to agriculture. The tropical luxuriance of the coast extends

inland through the interruptions in the edge of the plateau until it meets and mingles with the dry or upland vegetation.

Minas Geraes has no seaboard and nearly half of the state is within the São Francisco River Basin. The eastern portion communicates with the Atlantic through the Jequitinhonha, Mucury, Doce, and Parahyba do Sul rivers, all of which pass through regions containing forests similar to those of Espirito Santo. The hills rendering the eastern portion of the state so undulating are mere irregular ramifications of the culminating ridge, called Mantiqueira Range, which extends east and west and forms the divide between the São Francisco Basin sloping northward and the Paraná Basin draining southward. Nearly the whole of the state is a confused mountain mass. Rainfall is heavy during half the year, while the balance of the year is dry and hot in the depressions. The elevated parts are dry, bare, or overgrown with low shrubs, thorny plants, "carnaúba" palms, and clumps of coconut palms. Along the upper tributaries of the São Francisca River Paraná pine makes its first appearance and constitutes a conspicuous feature of the landscape, though it is not in sufficient quantity to be of commercial importance. "Yerba mate" occurs in the valleys. The country drained by the Parahyba and Rio Grande has a southern exposure and receives abundant rainfall and, since the region borders on the temperate zone, the vegetation here grades into an open hardwood type gradually becoming denser on the lower slopes and along rivers, where the growth is similar to that referred to in Paraguay proper and Misiones.

Rio de Janeiro occupies a narrow strip of the coastal plain between Espirito Santo on the north and São Paulo on the south. It has a coast line of about 450 miles and its greatest width is 300 miles. It is the most densely populated state of Brazil. It is well watered and entirely forested except along the coast where the swamps separate the littoral type from the purely semi-tropical forest formation. The principal river is the Parahyba which breaks through the coast range (Serro do Mar) and empties into the ocean at Campos. The coast range attains its greatest altitudes around the Rio Bay, rising precipitously to 6000 or 7000 feet. While many of the ledges are sheer rock, the gentler slopes are covered with forests which grade into a shrubby growth at higher altitudes.

São Paulo, second in importance of the Brazilian states, fronts on the Atlantic for 400 miles, and has a population of over two million. The people live near the coast and their principal industry is agriculture, particularly the growing of coffee, cotton, and sugar. The most impor-

tant cities are São Paulo, the capital, and Santos, the chief seaport town. Adjacent to the low coastal plain are two successive banks or precipitous cliffs which when viewed from the sea have the appearance of high mountains. The outer one is called the coast range and is about 2000 feet high, and the second or inner one is the Mantiqueira Range, about 5000 feet above the sea. The latter is continuous from São Paulo southward to Rio Grande do Sul and forms a barrier between the rivers draining the plateau westward and those flowing into the Atlantic. The entire slope was originally covered with forests similar to those of Rio de Janeiro and Espirito Santo, though the number of species is somewhat less and certain important trees, such as the rosewood (*Dalbergia nigra*) are wanting. Extensive areas have been cleared for agricultural crops, but a great timber wealth remains.

West of the Mantiqueiro ridge is the elevated plain lying between the Rio Grande and Paranápanéma, tributaries of the Rio Paraná which forms the western boundary of São Paulo. The surface is undulating and slopes toward Matto Grosso. Although the soil is rich and the rainfall is apparently ample for forests to develop, the air for the greater part of the year is so dry and the wind so incessant that the vegetation is largely of a semi-xerophytic type.

Paraná has a seaboard less than 100 miles long, and the only seaport town is Paranaguá. The capital, Curitibá, is located several miles inland. The topography of the state corresponds in a general way to that of São Paulo, and the coast range forming the huge seaward front of the interior plateau continues southward and some distance back from the coast. The semi-tropical vegetation characterizing the swampy plain gradually changes with increase in elevation until the top of the eastern slope is reached, where forests practically disappear. The plateau slopes gently toward the west and near its eastern edge are large areas of valuable Paraná pine forests alternating with savanna or brush land. The altitude is high enough for raising wheat and other temperate crops. In the west, the forests along the streams have a semi-tropical aspect, while those on the well-drained areas are park-like. In the luxuriant growth along the rivers are such useful timbers as "embuia," "canella," "louro," cedar, "peroba," "sassafras," "araribá," "canjarana," "oleo vermelho," and "páo ferro."

Santa Catharina, with a coast line of nearly 400 miles, occupies the region between the Iguassú on the north and the Uruguay on the south. The coast range or seaward edge of the great interior plateau rises abruptly from the narrow coastal plain, whose shore line is rendered

very irregular by the estuaries of the many small streams which head in the upper breaches of the huge seaward cliffs. The forests of the narrow coastal plain are distinctly semi-tropical and all the uncultivated areas outside of the swamplands are covered with dense forests similar to those of Rio de Janeiro. The coast range or seaward edge of the great interior plateau rises abruptly from the lowlands and its slopes are planted to coffee and other crops. The interior tableland has a fertile soil and a climate like that of southern Europe and is to an increasing extent being devoted to the growth of cereals and the raising of cattle.

The ridges of the irregular hills extending above the general elevation of the western slope of the plateau are entirely bare, while the slopes are covered with palms, brush, and Paraná pine. Large areas are covered with "yerba mate," which, as in Paraná, forms the basis of an important industry. Still further west forests occur only along the streams, while on the watersheds are savannas suitable for grazing. In the extreme west the forests resembling those of Misiones, Argentina, predominate, though large areas are covered with palms which attain their best development in the vicinity of swamps or on the lower slopes of moist hills. The commercial timbers are similar to those of Paraná.

Rio Grande do Sul, the southernmost state of Brazil, has a coast line of about 500 miles. The capital, Porto Alegre, is situated at the northern end of Lagoa Patos, an arm of the sea inclosed by barren sandy shoals. The coast range entering the state from the north turns sharply to the west and incloses the Uruguay Basin, but sends spurs southward where they are finally spent in Uruguay. To the east and south of the highlands is an undulating coastal plain with extensive marsh land surrounding the lakes of Patos and Mirim. The greater part of the lowland in the north is forested, but the uplands are largely undulating campos where sheep raising is the chief industry. The southern part of the coastal plain draining into the littoral lakes is a savanna chiefly valuable for raising cattle and horses.

Two-thirds of the state lies within the Atlantic drainage basin where the attenuated tropical vegetation does not appear to mingle with the more temperate species occurring on the upper slopes. The seaward slopes of the hills north and west of Porto Alegre were formerly heavily timbered, but the fertile soil is being largely reclaimed for agriculture. The forest conditions in the northwestern part of the state drained by the Rio Uruguay are much like those in Misiones, Argentina. True high forests occur along the rivers, but the ridges are either bare or are covered only with chaparral.

Falls of the Rio Jardão, Brazil.

Paraná Pine Forest in Southern Brazil.

Goyaz occupies a roughly wedge-shaped area of about 290,000 square miles, situated wholly within the Brazilian Highlands and extending through fifteen degrees of latitude. The surface is very undulating. The main ridge in the east forms the watershed between the Maranhão (Tocantins) on the west and Parnahyba and the São Francisco on the east. Another ridge constitutes the irregular mountain mass between the Maranhâo and the Araguay; this latter forming the western boundary line of Goyaz for nearly the entire length of the state. These tablelands rise gradually toward the south and culminate in the vicinity of Goyaz, the capital, where they form a transverse ridge extending in a general way from Formosa on the east to Santa Rita on the west.

Little information is available concerning the forests of Goyaz. The "chapados," flat elevated grassy tablelands dotted with trees or having regular parkscape of grass and woods, form a type prevalent throughout the southern and central portions of the state. In the south the country has a table-like appearance with numerous broad valleys sunken far below the general level; in the north and west the surface is broken by irregular ridges and deep gorges. The rivers flow in deeply sunken beds and the country is bare of trees, though brushland with palms alternate with savannas. Some of the valleys in the east and north are affected by the rains from the Amazon Valley and in places there are forests resembling those of the Amazon selva.

Matto Grosso, one of the largest and most backward states, occupies an area of over 500,000 square miles. The topography is not well understood and almost nothing has been published regarding it. The range of hills lying between the Araguay of the Tocantins drainage basin and the tributaries of the Amazon constitute the western slope of the Brazilian Highlands. About one-tenth of the state is drained by the Tocantins, while fully one-third lies within the River Plate Basin. The high ridge or divide on which Cuyabo, the capital city of Matto Grosso, is situated, may be regarded as the heart of Brazil, because from this point as the center, numerous irregular spurs and ridges extend in all directions maintaining, however, a sufficient continuity east and west to form a watershed between the Amazon and the Rio de la Plata basins. This is known as the Matto Grosso Plateau and is over 3000 feet high. On the southern slopes are vast stretches of savanna lands. Many of the hills are entirely bare and, while the river banks are forested farther to the south, the country is low and swampy, especially along the Rio Paraguay. The forests of the better drained areas vary, according to the character of the soil, from open and park-like to a dense jungle with palms and vines. The main divide between the Para-

guay and Paraná in the south is an extensive savanna which in part alternates with areas of low brush mixed with palms.

To the north of Matto Grosso Plateau and exclusive of the Tocantins drainage basin is the vast Amazon Basin, which is almost entirely unexplored. Naturalists have ascended all the large rivers discharging into the Amazon, but they have left no records regarding the character of the country. Most of these rivers periodically overflow their lower channels and flood the country sometimes for twenty miles or more, making it almost impossible to traverse the fluvial jungle. There undoubtedly are extensive savanna lands between the main rivers, as for instance between the Guapore and the upper branches of the Tapajos. The alluvial plains, which at one time formed the bed of a great interior lake, are not level, and the slightly elevated areas which are surrounded entirely by flood forests or typical selva, locally known as "gaa-fuazú," leave no gateway for high dry-land forms to enter these ecologically different areas.

Amazonas, occupying about 750,000 square miles in the extreme northwestern part of Brazil, is the largest state and one of the most sparsely populated. The great majority of the people are Indians, scattered in small tribes, many of whom are hostile. With the exception of a small portion of the Guiana Highlands, the entire state is relatively low and very marshy along all water courses. It lies wholly within the Amazon Basin and is traversed by many rivers.

The region has been explored only along the rivers. There are no roads or railroads and only a few towns, chief of which is Manaos, the capital. All of these riparian towns had their origin in the rubber trade which at one time flourished throughout the entire Amazon country. The forests are generally described as being continuous throughout the basin and are said to be unsurpassed in density, rankness of growth, and wealth of species. The region is not sufficiently well known to accept unreservedly the claim as to the continuity of the dense jungle between the rivers. Even along the rivers where the vegetation is the densest there are many larger or smaller treeless areas and there are indications that these increase both in number and extent as one goes inland at right angles to any of the large Amazon tributaries, and their aggregate area is probably very great. Almost endless stretches of these savanna lands skirt the northern boundary along Venezuela and Guiana and the same is true along the Colombian boundary between the main rivers draining the trans-Andean Montaña.

PART II.

THE TREES AND THEIR WOODS

INTRODUCTION

THIS work deals with 75 families having trees growing naturally in tropical America, the emphasis being placed upon those of greatest interest from a commercial standpoint. The general plan followed is to introduce each family with a brief consideration of its size, distribution, and economic importance, attention being directed to some of the best known members as a basis for identification and comparison. This is usually followed by a summary of the salient structural features of the woods, after which the more important genera and species are dealt with in such detail as their importance seems to warrant or available information will permit. The sequence of the families and of the genera in the larger families is according to the classification of Engler and Gilg (1912). In most cases the number of species accredited to a family or a genus is derived from the Index Kewensis. For various reasons the nomenclature does not adhere rigidly to a single system but the common synonyms are included so as to avoid any doubt as to the identity of a given species. Two apparently new species of commercial importance are described and given provisional names.[1]

DETAILED DESCRIPTIONS OF THE WOODS

Common names. These have been compiled from a great many sources, and especially from the publications cited in other parts of the text. Credit for the Mexican and Salvadorean names is largely due to Dr. Paul C. Standley. Too much reliance should not be placed upon vernacular names in attempting to establish the botanical status of a wood, since the same name is often applied to several entirely different kinds and there is also, of course, the liability of error in the original labeling of a specimen.

General properties. Color, odor, and taste are described with reference to the heartwood, unless otherwise stated. Fresh material is preferable, but often this is not available. The sensations of odor and taste are very difficult to describe and attempt to do so has been made only in distinctive cases.

The determinations of specific gravity were made in the laboratory of the Yale School of Forestry, except where other authority is given, and are mostly based on thoroughly air-dry material. The weights per cubic foot are on the same basis.

[1] These are *Pithecolobium Vinhatico* and *Tecoma Peroba.*

The term grain relates to the arrangement or direction of the elements. Roe or ribbon grain refers to woods in which fiber layers alternate in direction, giving boards a striped effect which changes with the lighting or the angle at which viewed. Silver grain refers to the conspicuous appearance of the rays on the radial surface, being most pronounced in quarter-sawn oak. The relative size of the cells determines texture; thus a coarse-textured wood has many large cells, especially vessels, while a fine-textured one has very small elements.

By durability is meant the natural resistance of heartwood to decay when in contact with the ground. This property can be inferred with a fair degree of accuracy from the color and odor, since woods that are deeply colored, or are heavily infiltrated with resins and gums, or have a pronounced aromatic scent are usually slow to rot. Sapwood is never noted for its natural durability. The suitability of tropical timbers for railway cross-ties in temperate climates cannot be determined satisfactorily except by means of adequate service tests. No woods have been found that are immune to the attacks of all shipworms, though there are a few that are highly resistant. The presence of silica particles in the wood is said by Gonggrijp (see page 197) to be an indication of resistance to the teredo, but not to decay.

Growth rings. Most tropical woods have more or less clearly defined zones of growth which are evidenced by local variation in porosity, density, or special arrangement of the elements. Such rings owe their origin to various causes and, while often seasonal, it is not known to what extent they correspond to annual periods. Very few tropical woods are ring-porous.

Parenchyma. The term as used in the descriptions applies to the vertical food cells which are of softer tissue than the fibers. The abundance and arrangement of these cells provide a very important diagnostic feature. In some woods they are apparently absent, in others confined to the vicinity of the vessels, in others producing lines showing a great range of variability in different species. The distinctness of parenchyma is usually, but not always, increased by moistening the smoothly cut surface. Sometimes the parenchyma bands show plainly on longitudinal sections and may give rise to distinct pattern on the tangential surface.

Pores. This term is applied to vessels or tracheae as seen on cross section. The relative size, abundance, and arrangement of the pores are features of importance, but are subject to variation as a result of conditions of growth. Pores are absent in the Gymnospermae and in *Drimys* (Magnoliaceae) of the Angiospermae.

Cross Sections of the Wood of Mahogany.

Left: As seen with unaided eye.

Middle: As seen under hand lens.

Right: As seen under low power of compound microscope.

The transverse lines are parenchyma; the vertical lines are the rays; the larger openings are the pores; the remainder is composed mostly of wood fibers.

Tangential Section of Cocobolo Wood.

As seen under low power of compound microscope. The cells are in horizontal series, producing fine file-like cross lines called ripple marks.

Vessel lines. These are seen on longitudinal surfaces. Their distinctness is governed by their size, contents, and associated tissue, particularly parenchyma. They often give the characteristic "grain" or figure to wood as, for example, in Spanish cedar and "acapú."

Vessel contents. The usual contents are tyloses, gums, resins, and white substance. The last may be of a mineral or a gummy nature. In some instances these deposits provide a ready clue to the identity of a specimen, as, for instance, in certain species of *Tecoma* and in *Phyllostylon.* Tyloses are outgrowths of a cellular nature which pass through the pits from parenchyma cells into vessels. They may be absent, sparingly developed, or completely fill the cells. They are usually thin-walled, froth-like, and unpitted, but sometimes are of medium thickness and pitted and in *Piratinera* may become sclerosed and resemble stone cells.

Rays. Rays, also known as medullary or pith rays, are ribbons of parenchyma cells running at right angles to the axis of the tree and connecting the wood and bark. They vary in size from minute and indistinct, even with a hand lens, on cross section, to large and conspicuous as in oak and representatives of the Dilleniaceae, Myrsinaceae, and Proteaceae. They are always visible though often inconspicuous on radial surface, and in some instances give a beautiful figure to quarter-sawn (radially cut) lumber. Their distinctness depends upon their contrast in color and luster with the fiber background, as well as upon their size and contents.

Ripple marks. These are the fine transverse striations or file-like markings produced in woods which have a storied or tier-like structure of their elements. Usually in such cases all the elements are in seriation, but sometimes only a part of them are so arranged. Parenchyma with a definite number of cells per strand may be present in sufficient amount to produce a secondary seriation invisible without the lens. Ripple marks are a highly valuable aid in identification. They have been observed in tropical American woods of the following families: Bignoniaceae, Bombacaceae, Leguminosae, Malvaceae, Meliaceae, Nyctaginaceae, Rutaceae, Simarubaceae, Sterculiaceae, Surianaceae, Tiliaceae, Ulmaceae, and Zygophyllaceae. Most of the woods with ripple marks belong to the Leguminosae.

Gum ducts. These are intercellular canals in dicotyledonous woods corresponding to the resin ducts of certain conifers. They may be vertical in association with the wood parenchyma, or horizontal and included in certain of the rays, but in no American wood have the two

kinds been found together as they are, for example, in *Pinus*. The vertical ducts may be of normal occurrence or they may arise only as the result of injury, or pathologically. Vertical ducts have been observed in tropical American woods of the following families: Bombacaceae, Borraginaceae, Combretaceae, Hamamelidaceae, Leguminosae, Meliaceae, Rutaceae, Simarubaceae, Sterculiaceae, and Vochysiaceae; they appear to be of normal occurrence only in *Copaifera*, *Eperua*, *Prioria*, and possibly *Hymenaea* of the Leguminosae and in *Simaruba* of the Simarubaceae. Radial canals are of normal occurrence in certain representatives of the Anacardiaceae, Araliaceae, Burseraceae, and Guttiferae.

Minute anatomy. The most important features of the vessels are the perforations and the wall markings (pits and spirals). The perforations, or apertures between segments, are usually either simple (*i.e.*, with a single circular to elliptical opening) or scalariform (*i.e.*, with a grating) with few to many bars; rarely of composite or special type. Scalariform perforations (exclusively or in part) characterize the following: *Ilex* (Aquifoliaceae), *Didymopanax* (Araliaceae), *Alnus* (Betulaceae), Canellaceae, Caprifoliaceae, *Goupia* (Celastraceae), Cunoniaceae, Cyrillaceae, *Curatella* (Dilleniaceae), Eucryphiaceae, *Hamamelis* (Hamamelidaceae), *Humiria* (Humiriaceae), *Magnolia* and *Talauma* (Magnoliaceae), Monimiaceae, Myricaceae, Myristicaceae, *Minquartia* (Olacaceae), *Platanus* (Platanaceae), *Rhizophora* (Rhizophoraceae), Saxifragaceae, *Symplocos* (Symplocaceae).

Rays are said to be homogeneous when all of the cells are procumbent and are of comparatively uniform size. If part of the cells are square or upright the rays are classed as heterogeneous. Pits between the ray cells and vessels are very distinctive and while always simple on the ray side may be bordered or simple on the vessel side. The size, shape, and arrangement of these pits are important in classification. The rays of certain woods contain latex tubes which are usually larger than the surrounding cells and are distinguished from gum ducts in that they are provided with a wall instead of being intercellular spaces. Latex tubes have been found in certain of the Moraceae and Euphorbiaceae.

Wood fibers usually make up the ground mass of the wood. The features of importance are their arrangement, thickness of wall, kind of pitting, and presence or absence of septations and of gummy contents. Septate wood fibers always have simple pits. Sometimes wood fibers are falsely septate due to thin partitions of gum or resin and these may be confused with structurally septate fibers.

Anomalous structure. Except in the lianas, the anomalies of wood structure consist mostly of inclusions of soft bast (phloem and phloem parenchyma) within the woody cylinder. These may be in the form of isolated strands as in *Mouriria* (Melastomaceae) and *Pisonia* (Nyctaginaceae), or as concentric and anastomosing layers as in the Phytolaccaceae and *Avicennia* (Verbenaceae).

SOURCES OF INFORMATION

THE descriptions of the trees were taken from many different sources, most of which are indicated in the text. In addition to the published works the authors have had at their disposal the notes made in the field by one of them (Mr. Mell), and also a great wealth of data in the form of manuscripts and verbal and written reports by persons familiar with specific regions. Special acknowledgment is due to Mr. Hugh M. Curran, Collaborator in Tropical Forestry, Yale University, for his personal assistance and generous contribution of field notes, photographs, and collections obtained during nine years of experience in the forests of Argentina, Colombia, Venezuela, the West Indies, and eastern Brazil; and to Dr. H. N. Whitford, Assistant Professor of Tropical Forestry at Yale, for his cooperation both personally and through his collections and notes covering expeditions into Mexico, Central America, Colombia, Venezuela, Dutch Guiana, and eastern and southern Brazil.

All of the extended descriptions of the woods and such of the others as do not indicate a different source are made directly from the material in the collections of the School of Forestry, Yale University. The specimens examined are cited by the numbers in the serial catalogue, thus making it possible to refer to the material at any time for further information or for purposes of comparison. Specimens accompanied by botanical material obtained from the same tree were used as the types wherever possible and even then the material was carefully scrutinized in the light of all data available to guard against errors. In various doubtful cases invaluable assistance was rendered by correspondents in different tropical American countries, the material thus obtained serving to dispose satisfactorily of some vexing problems. Special credit in this connection is due to Mr. J. W. Gonggrijp, Conservator of Forests of Surinam; Mr. L. S. Hohenkerk, Forestry Officer of British Guiana; Dr. Henry Pittier of the Museo Comercial de Venezuela, Caracas; Mr. G. C. Bucher, Santiago, and Mr. E. Duque Estrada, Havana, Cuba; Mr. J. Pinzón C., Bogotá, Colombia; Messrs. E. Palazio & Co., Corinto, Nicaragua; Mr. Alberto Fait, Puntarenas, Costa Rica; Mr. John A. Gamon, U. S. Consular Service, Acapulco, and Mr. A. M.

Garcia, Monterrey, Mexico; Mr. W. H. Bourne, Punta Gorda, British Honduras; and Mr. P. H. Myers, Puerto Cortes, Honduras.

Collections of tropical American woods entering the markets of the United States and information concerning their source, uses, and properties were obtained from various dealers, importers, and manufacturers. Prominent among these were the C. H. Pearson & Son Hardwood Company, 29 Broadway, New York City; Messrs. Schmieg & Company, 521 East 72d Street, New York City; Messrs. J. H. Monteath & Company, 202 Lewis Street, New York City; Mr. Arthur W. Betts, New York City; American Balsa Company, 50 East 42d Street, New York City; Panama American Timber Corporation, Emporium, Pa.; American Dyewood Company, 80 Maiden Lane, New York City; Stamford Dyewood Company, Stamford, Conn.; Messrs. Richard Levering & Company, New York City; The Goodell-Pratt Company, Greenfield, Mass.; Montague City Rod Company, Amherst, Mass.

The identifications of the botanical material accompanying wood specimens were made by Dr. S. F. Blake, U. S. Bureau of Plant Industry; Dr. Paul C. Standley, Smithsonian Institution, Washington, D. C.; Dr. Percy Wilson and Dr. P. A. Ridberg, New York Botanical Garden; and Dr. J. Francis MacBride, Harvard University.

CLASS I. GYMNOSPERMAE

All of the higher or seed-bearing plants are separable into two classes —the Gymnospermae and the Angiospermae. The significance of these names lies in the fact that in the one case the seeds are borne naked on the face of a scale while in the other the fruit contains the seeds in a closed cavity. All the members of the Gymnospermae are resinous trees or shrubs with stems composed of a cylinder of wood surrounding a central core of pith and enveloped by the bark. Between wood and bark is a thin layer of generative tissue, the cambium, by means of which the stem increases in thickness. Some of the representatives are timber trees of great importance and supply the bulk of the lumber used throughout the civilized world. The principal group is the Coniferae or cone-bearers, embracing two families, the Taxaceae and the Pinaceae. Coniferous forests are largely confined to temperate regions.

1. TAXACEAE

The Yew Family consists of nine or ten genera and about 140 species of trees and shrubs of the temperate and tropical regions of the world. It is distinguished from the true conifers chiefly by the fruit which contains a single seed unprotected by hardened scales.

TAXUS

The best known members of the family are the yews, *Taxus*, of which there are six or seven species and numerous varieties of shrubs and small trees extensively cultivated for ornamental purposes and yielding a reddish, fine-textured, hard, and elastic wood prized for archery bows. The genus is represented in tropical America by one Mexican species, *Taxus globosa* Schl., a small tree in the forests of the States of Vera Cruz, Hidalgo, Mexico, and Oaxaca. The wood of the yews is characterized by the complete absence of resin ducts and resin cells and by the presence of spirals in the tracheids.

PODOCARPUS

The largest genus of the family is *Podocarpus*[2] with upward of 100 species, many of which are imperfectly known. The genus is most abundantly represented in the southern hemisphere, attaining the best development and being of greatest commercial importance in South Africa and New Zealand. There are numerous species in the New World, extending from the West Indies and southern Mexico to Chile. Some of the trees are large and well formed, but they usually occur sparsely in the high mountains and consequently are of minor importance as a source of commercial timber. The yellowish or brownish woods are of fine and uniform texture, easy to work, and highly esteemed locally for the same purposes as white pine (*Pinus Strobus* L.). They differ in structure from *Taxus* in having numerous resin cells, suggesting bald cypress (*Taxodium*), and in the absence of spiral tracheids. The common names are: Cobola (C. R.); pina blanca (Pan.); chaquera, pino, pino de pacho (Col.); pino, pino veti (Venez.); sabina cimarróna (Cuba); pinheirinho (Braz.); pino (Arg.); mañiu (Chile). *Material:* Yale Nos. 383 (Col.); 460* (Venez.); 6736* (Pan.); 1769 (Arg.); 3750, 5549 (Chile). Asterisk indicates botanical material.

2. PINACEAE

The Pine Family consists of 29 genera and about 250 species of trees and shrubs widely distributed over the world, but most abundantly in north temperate regions. From the standpoint of timber production this is the most important family of all, containing, as it does, the pines,

[2] Some botanists include *Podocarpus, Dacrydium, Microcachrys,* and *Saxegothaea* in a separate family, the Podocarpaceae.

spruces, firs, hemlocks, cypresses, and cedars. Of the 14 genera[3] in the New World, 13 are represented in the United States, seven in Mexico, five in Central America, two in the West Indies, and three in South America.

ARAUCARIA

There are two important species of *Araucaria* in South America, namely *A. imbricata* Pav. in central Chile and Patagonia, and *A. brasiliana* Lamb., the Paraná pine of southern Brazil. The botanical range of the latter species includes portions of Paraguay and Misiones, Argentina, the plateau region of the Brazilian states Paraná, Santa Catharina, Rio Grande do Sul, and small areas of Minas Geraes, and São Paulo. The tree also occurs scatteringly in the mountains of Rio de Janeiro, Espirito Santo, and Bahia, but it is not unlikely that this northern extension of the range represents escape from cultivation by the early settlers or to dissemination by the aborigines who used the seeds for food. The commercial range is limited to about 100,000 square miles centering in the State of Paraná. (Plate XVIII.)

The mature trees are from 80 to 120 feet high with straight stems bearing at the top clusters of limbs upturned and tufted at the ends, giving the effect of giant candelabra. The forests, unlike the usual pine forests, are not open and park-like, but are stocked with a dense undergrowth of hardwoods except where these have been cleared away to make room for the cultivation of holly bushes, the source of the famous Brazilian or Paraguay tea or "herva mate." Some operators cut only pine, but others include a limited amount of hardwoods, principally "embuia" (*Nectandra* sp.).

The Paraná pine is the most extensively exploited timber in South America and supplies upward of 150,000,000 board feet of lumber for the cities of the Brazilian coast, and the rapidly developing agricultural regions of southern Brazil, and of Paraguay and Argentina. The logging and milling operations are conducted with modern equipment identical with that in use in the pine forests of southern United States. The industry is capable of great expansion, but the need for coniferous lumber for construction purposes in South America is so great that Paraná pine probably will never become an important factor in the markets of the rest of the world.

[3] United States: *Pinus, Larix, Picea, Tsuga, Pseudotsuga, Abies, Sequoia, Taxodium, Libocedrus, Thuya, Cupressus, Chamaecyparis,* and *Juniperus.* Mexico: *Pinus, Pseudotsuga, Abies, Taxodium, Libocedrus, Cupressus,* and *Juniperus.* Central America: *Pinus, Abies, Taxodium, Cupressus,* and *Juniperus.* West Indies: *Pinus* and *Juniperus.* South America (southern part): *Araucaria, Fitzroya,* and *Libocedrus.*

Paraná Pine Growing in the Open, Brazil.
(*Araucaria brasiliana.*)

Pure Stand of Fir in Mexico.
(*Abies religiosa.*)

PLATE XX

THE WOOD

Araucaria brasiliana Lamb. *Paraná Pine.*

Common names: Paraná pine (Eng.); pinheiro do Paraná, pinho, pinho branco, pinho vermelho (Braz.); curiy, kuviy, pinho, pino (Arg.); curi-y, pinheiro do Brasil, pino blanco, pino colorado (Par.).

General properties: Color variable from light to dark brown, sometimes bright red in part. Sapwood nearly colorless.

Odor and taste absent or not distinctive.

Light and soft to moderately hard and heavy. Sp. gr. (air-dry) usually between 0.50 and 0.60, though said to be as high sometimes as 0.865. Weight 30 to 40 lbs. per cu. ft. Grain mostly straight. Texture medium, uniform. Wood easy to work, finishes smoothly, is fairly strong, not highly durable.

Growth rings: Present; fairly distinct; due to slightly denser late wood; transition from early wood to late wood gradual.

Parenchyma: Absent.

Tracheids: Rather large; arranged in definite radial rows; bordered pits commonly in two or more rows, crowded near ends, *alternate;* Sanio's beams common; resinous tracheids often present.

Rays: Very fine; faintly visible on cross section and sometimes also on tangential; low, but distinct, on radial surface, usually appearing darker than background; uniseriate; pits in tracheids numerous, small, half-bordered; ray tracheids absent.

Resin ducts: Absent.

Remarks: Readily distinguished from pine (*Pinus*) by absence of resin ducts and ray tracheids; from other conifers by the crowded and alternate pitting of the tracheids.

Material: Yale Nos. 521, 539, 899, 1139 (Arg.); 2511, 3319, 4127, 4924 (Braz.).

PINUS

The pines, the most important group of timber trees in North America, are largely confined to temperate regions. There are no pines in South America. There are numerous species in Mexico[4] but their vertical range is approximately between 4000 and 15,000 feet above sea level, and even at the lowest of these altitudes the climate is only sub-tropical. The species are divisible into three groups, (1) the white pines, (2) the foxtail and nut pines, and (3) the pitch pines, which are readily distinguishable on the basis of their wood structure.[5] From the standpoint

[4] According to G. R. Shaw (*The pines of Mexico,* Boston, 1909) there are 18 species and 17 varieties, but Paul C. Standley (Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.,* 23: 1: 50-58, 1920) considers some of these varieties worthy of specific rank and enumerates 26 species, 11 of which occur also in the United States and four in Guatemala.

[5] See Record, S. J.: *Identification of the economic woods of the United States,* John Wiley & Sons, Inc., New York, 1919, pp. 74-77.

of timber production, the pitch pines are the most valuable and supply considerable quantities of lumber, corresponding to our western yellow pine (*P. ponderosa* Laws.), for local consumption and also for export. The fact that the trees occur in the mountains and are often poorly accessible interferes with their exploitation and consequently most of the pine lumber consumed in Mexico is imported from the United States.

Pine is abundant in parts of Guatemala, Honduras, British Honduras, and Nicaragua, and occurs in small amounts in Salvador and northern Costa Rica. There are at least five[6] species in Guatemala, the most important commercially being the Cuban or slash pine, *Pinus caribaea* Mor. This species is common in southern Florida and the coast regions of the southern states where it gradually replaces longleaf pine (*P. palustris* Mill.); and on the Bahamas, the Isle of Pines, and the lowlands of Honduras and eastern Guatemala. The pitch pine of the other portions of Central America is the same or a closely related species. The trees are rich in oleo-resin and the forests are becoming an important source of turpentine and other naval stores. The timber averages heavier than longleaf and contains a greater amount of resin.

The following information regarding the pine of Nicaragua is supplied by Mr. F. H. Fischer, of the Central America Sawmills, Cape Gracias:

The pine (Spanish, "pino" or "ocote"; Miskito Indian, "auas") occurs in scattered belts and ridges from the coast to the hills in northern Nicaragua and Honduras. The stand is usually thin and in patches with "bush" land intersecting along all creeks and rivers. No estimate of the stand per acre is available.

The logs are rolled into the creeks or hauled with ox teams and 8-wheeled wagons to the rivers, where they are made into rafts and floated to the mill on the coast. Cross-poles of young pine or bamboo are used in making the rafts and the logs are bound together into cribs of ten or twelve by very long and tough vines which are as good as rope for the purpose. When a certain lot contains many "sinkers" enough "polak" or "balsa" logs are placed in the rafts to keep them afloat.

Only timber of good quality is sent to the mill, the minimum diameter of the logs at the small end being 12 inches, and the average length about 18 feet; the mill run is about 135 feet per log. The quality of the timber varies with the locality, but is excellent on the whole, being dense, close-grained, and largely heartwood. Prominent lumbermen of the United States consider it equal to longleaf yellow pine of the South.

[6] The five species are *Pinus ayacahuite* K. Ehr., *P. Pseudostrobus* Lindl., *P. montazumae* Lam., *P. oocarpa* Scheide, and *P. caribaea* Morelet.

Although pine occurs on several of the West Indian islands it is of commercial importance only in the Dominican Republic. Durland[7] says:

The pine forest of the Dominican Republic is of more interest commercially than all of the other forest types put together. This can be explained perhaps by the fact that pine lumber has long been used and is well-known, chiefly because foreign pine has been extensively imported for general construction purposes. The species is resinous and heavy, barely floating in water. In past years a few attempts have been made to exploit this pine, but operations have been on a small scale and of a temporary nature. The still unsettled status of land ownership and the previous unstable conditions of the native government have made exploitation as a business enterprise practically impossible, whence the lack of development of what is considered to be a domestic source of construction lumber and the unmolested condition in which this pine is found.

The boundaries of the pine forest are usually sharply defined. As a type it occupies the northern slopes of the main range from the vicinity of Cotui west to the Haitian border. Botanically the formation is not complex, 80 per cent and over of the surface area being covered by one species of pine identified as *Pinus occidentalis*. In appearance the type somewhat resembles the open parklike stands of pine in our own southern states though it is far less abundant per acre. It ranges in diameter on the average from 12 to 25 inches breast-high and in total tree height from 40 to 60 feet. Eggers reports that at the higher elevations (4000 feet) individuals approaching 200 feet in height and four feet or more in diameter are not uncommon. The trees are scattered more or less singly over the area in a very open manner, on the ridges in particular. They are found at times, although exceptionally, in dense pure stands. A luxuriant growth of wild grass over which cattle graze at will forms a ground cover beneath the pine. This ground cover is coincident with the occurrence of the pine and is characteristic of the type.

Common names: Pine (Eng.); acalocahuite, acanita, ayacahuite, ayacahuite colorado, guiri-biche, jalicote, ocotl, ocote, ocote blanco, ocote chino, ocote hembro, ocote macho, pinabete, pino acahuite, pino barbón, pino cahuite, pino de azúcar, pino Montezuma, pino piñon, pino prieto, pino real, pino triste, piñon, sacalacahuite, xalócotl, yutmusatnu (Mex.); pino, ocote (C. R., Nic.); auas (Miskito Indians); pino (Cuba); pichipin (S. D.).

Material: Yale Nos. 75, 123, 216, 248 (Hond.); 3715*, 3735* (Guat.); 4409 (Mex.); 801 (Cuba); 4821* (Haiti); 5030 (S. D.). Asterisk indicates botanical material.

PSEUDOTSUGA

The Douglas fir of western United States, *Pseudotsuga taxifolia* Britt., extends into Mexico as far south as Hidalgo, but is confined to

[7] Durland, W. D.: "The forests of the Dominican Republic," *Geogr. Review*, 12: 2: 216, Apr., 1922.

the high altitudes and does not supply timber in commercial quantities. The other species, *P. macrocarpa* Mayr, is found in the San Pedro Mártir mountains of Lower California at elevations of 5000 to 7000 feet. The woods of this genus are readily distinguished from the pines by the presence of spiral tracheids.

Common names: Douglas fir, red fir, Oregon pine (Eng.); abeto, acahuite, cahuite, hallarín, pinabete, pino de corcho (Mex.).

ABIES

There are two firs in Mexico. The white fir, *Abies concolor* Lindl., one of the largest trees in western United States and much planted for ornamental purposes, occurs in the mountains of northern Mexico. Another species, *Abies religiosa* (H. B. K.) Schl. & Cham., is a larger tree growing in the mountains (4000 to 11,000 feet elevation) of central Mexico and southward into northern Central America. (Plate XX.)

Standley (*loc. cit.*, p. 59) says: "This fir tree furnishes considerable lumber which is used for various construction purposes, as well as for making paper. The trees are tapped in winter for the oleoresin which they yield abundantly. This, known as 'aceite de palo' or 'aceite de abieto,' is used in medicine for its balsamic properties, and as an ingredient of paints. The specific name '*religiosa*' was applied to the tree because of the fact that its branches are often used as decorations in churches."

Common names: Fir (Eng.); abeto, acxoyatl, bansú, guayame, huallame, jalacote, oyamel, oyametl, pinabete, pino, pino oyamel, xalócotl (Mex.); cipreso (Guat.).

TAXODIUM

Two species and a variety of *Taxodium* or bald cypress are recognized. The well-known cypress lumber of southern United States is the product of *T. distichum* Rich., a large deciduous tree usually occurring on wet lands and in swamps, sometimes in pure stands. Where growing in water the roots often send up peculiar conical projections called "knees," presumably for purposes of aeration.

The Mexican bald cypress, *T. mucronatum* Ten., occurs, chiefly in wet soil, from Sinaloa to Coahuila and southward into northern Central America. In habit of growth and in the structure of its wood it is much like the other species. The lumber, often obtainable in very large sizes, is used locally for furniture and general construction, but the tree is better known as a shade tree and particularly on account of the enormous size of famous individuals. One at Santa Maria del Tule near

the city of Oaxaca is said to be 125 feet high with a trunk nearly 170 feet in total circumference and 40 feet in greatest diameter, supporting a crown spreading about 140 feet. The cypress of Montezuma, in the gardens of Chapultepec, is about 165 feet high with a trunk circumference of nearly 50 feet, and was a noted tree 400 years ago.

Common names: Bald cypress (Eng.); ahuehuete, ahuehuetl, ciprés, ciprés de Montezuma, cipreso, pentamón, pentamu, sabino, tnuyucu, yaga-chichicino, yaga-guichi xiña, yucu-ndatura (Mex.).

JUNIPERUS

This genus consists of about 35 species, mostly small trees and shrubs, widely distributed over the world. The wood is noted for its fine and uniform texture and its fragrance and is considered the only satisfactory material for the manufacture of lead pencils, though considerable quantities of the incense cedar of California (*Libocedrus decurreus* Torr.) are now being used for this purpose. The quest for new sources of supply of juniper or red cedar has met with little success.

There are four or five species in Mexico, all of which occur also in our arid Southwest, two of them extending into northern Central America. They are found scattered in the mountains and are of such poor timber form as to be without value except for local use as posts, poles, fuel, and miscellaneous minor purposes.

There are two or three species of juniper in the West Indies and one of them, *Juniperus barbadensis* Sarg., is common in southeastern United States. Some of the timber has been exported from the West Indies and there is a considerable supply remaining in the Dominican Republic, but the trees are scattered and so difficult of access as not to warrant its exploitation at present.

Common names: Juniper, red cedar, pencil cedar, savin (Eng.); cedro, cedro colorado, enebro, sabino, tascate, taxate, yutnu-itne (Mex.); enebro criollo, sabina de costa (Cuba); sabina (S. D.).

CUPRESSUS

There are several species of cypress in western United States and Mexico, at least one of them extending as far southward as Costa Rica. The trees, which are much like the junipers except that their cones open at maturity and liberate their seeds, vary greatly in size, sometimes reaching a height of 100 feet. They occur scatteringly and their timber is of little commercial value, though used locally for many pur-

poses. The wood is fine-textured, mostly light-colored, durable, and varies from light and soft to hard and heavy.

Common names: Cypress (Eng.); cedro, cedro amarillo, cedro blanco, cedro de la sierra, ciprés, ciprés de Mexico, gretado amarillo, gretado galán, pinabete, teatlale, tlascal, tlascale, tlatzcán, tlazzcán (Mex.).

CLASS II. ANGIOSPERMAE

This class is very much larger than the Gymnospermae and contains, in addition to the trees and shrubs, a vast number of herbaceous plants. There are two divisions, namely, the Monocotyledons or plants with a single cotyledon or seed leaf, and the Dicotyledons or plants with two rudimentary leaves in the embryo of the seed. The first division is much the smaller, but some of its representatives, particularly the palms and the great group of grasses, are of incalculable value to man as sources of food and special products. The tree forms are confined almost exclusively to the tropics and sub-tropics and do not produce lumber, though their stems supply exceedingly useful material for local construction and miscellaneous purposes. These stems are essentially different in structure from those of the Gymnospermae and Dicotyledons in that they are unbranched, have woody fibers irregularly scattered through them, are without pith and bark, and increase in size by the addition and development of new strands within rather than by successive layers laid down by a cambium sheath. The leaves are parallel-veined and the parts of the flowers are in threes. The only family considered in this work is the Palmaceae.

The Dicotyledons include the so-called hardwoods or broad-leaved trees, such as are so common in temperate regions and which make up the great bulk of the tropical timbers. The leaves are netted-veined and the parts of the flowers are commonly in fives or fours. The development of the stem is the same as in the conifers, but the wood is more complex in structure and exhibits a wider range of variation in all of its properties. The great variety of tropical American hardwoods available makes possible the selection of material suitable for every purpose for which wood can be used.

Division I. Monocotyledons

3. PALMACEAE

The Palm Family consists of about 125 known genera, embracing no less than 1200 species, most of which are tropical. The palms were referred to by Humboldt as "the princes of the vegetable kingdom,"

and they may indeed be regarded as one of nature's greatest gifts to man, particularly in the tropics where they grow most abundantly and luxuriantly. Every known palm growing in regions inhabited by man has its peculiar uses, and the people appreciate them not only for their beauty and shade, but also for the varied and valuable products they yield. Economic palm products are obtained from all parts of the trees. The roots, trunks, pith, leaves, flowers, and fruits are variously used for food, drink, medicine, or means of providing shelter as well as for such technical products as tannins, dyes, sugars, waxes, oils, fats, fiber, timber, ivory substitute, and other materials of more or less importance.

The palms are confined chiefly to the tropics, and in the western hemisphere their geographical distribution extends from 36 degrees north latitude to 38 degrees south. They are most abundant at the equator, as regards both number of species and of individuals, decreasing to the north and south and also in ascending the slopes of the high mountains, though a few species are said to flourish on the elevated paramos in Colombia, Ecuador, Peru, and Bolivia, at altitudes of 14,000 feet, which is well above the timber line. Notwithstanding the fact that the palms as a group are scattered over such a wide range of elevation, they find their optimum development near the sea level as in the Amazon Valley. In general they prefer a moist soil and do not appear to suffer in ground that is distinctly saline, although many species grow also in the arid interior and elevated plateaus of tropical America.

The fundamental plan of all the well-known palms is strikingly similar, although the general appearance, size, and products of the various species differ markedly. Some attain great size, as for instance, the royal palm, *Oreodoxa*, and the wax palm, *Ceroxylon*, of Colombia and Ecuador; others are small and delicate as in the case of the *Geonoma*, in which stems are sometimes entirely wanting above the ground or are less than three feet high. Of those that develop trunks not all are straight and erect, some assuming the form of a vine like the rattans of the Far East; the "jacitará," *Desmoncus*, of Brazil is the best example of this type, and its trunks are scarcely as thick as a lead pencil and sometimes more than a hundred feet long. In all palms, however, the outer portion of the trunk consists of fibro-vascular bundles imbedded in a mass of parenchyma tissue. Near the surface these bundles, which are horn-like and very strong, are very numerous, but decrease toward the center and finally disappear entirely. In some species this outer shell of the trunks is relatively thin with numerous fine bundles crowded densely together, while others have a thicker but less compact layer with much

larger and intertwining strands. The stems with the densest layers and smallest bundle strands supply material of beautiful figure and susceptible of very high polish and is accordingly in demand for the manufacture of walking sticks, umbrella handles, and fishing rods.

The leaves are always crowded at the summit of the stem and some of them surpass in size those of any other form of vegetation. In shape they vary from the general type of the pinnate frond of the coconut or of the cohune palm, which is sometimes 40 feet long, to the palmate or entire leaf not longer than a man's hand. In whatever form or size these leaves develop, they can be, and pretty generally are, used throughout tropical America for thatching and siding the rude huts of the natives as well as for various other purposes.

The fruits, popularly known as nuts, vary in size from that of a pea to that of the coconut and are generally borne in clusters in the axils of the lower and older leaves or fronds. Some of the fruits are edible in the unprepared state, and most of them contain an oil which can be expressed and used for food.

Only the four most important genera will be considered in detail.

ATTALEA

This genus consists of about 25 species scattered throughout the tropical parts of America, of which at least two species have attained economic importance, namely the cohune palm, *Attalea Cohune* Mart., of Central America, which produces an abundance of nuts (fruits) whose kernels yield oil, and the "piassaba," *A. funifera* Mart., of Brazil, the source of the piassaba fiber.

The cohune palm occurs from southern Mexico southward to Colombia, where it begins to grade into several other species, attaining its best development in Guatemala and Spanish and British Honduras. In the latter country, it has been estimated that fully two-fifths of the area of approximately 37,500 square miles, is covered with cohune forests. In Spanish Honduras and Guatemala it is confined largely to the sandy or well-drained uplands known as cohune ridges where, in different stages of its growth, it forms from 20 to 30 per cent of the vegetation. In British Honduras it occurs to some extent in the hardwood forests composed of cedar, mahogany, fustic, sapodilla, etc. It appears, however, that the cohune grows best on abandoned cleared areas. (Plate VII.)

While every part of the cohune palm is used by the natives, the most valuable part is the fruit which is borne in large clusters weighing some-

times as much as 200 pounds and being two or three feet long. The fruit has a tough outer fibrous layer known as the pericarp which is about one-half inch thick. While this outer layer contains some fat, it is not likely to be of value under present conditions for making palm nut oil. After the pericarp is removed there remains the so-called "nut" which measures from two to three inches in length and about an inch and a half in diameter. It has a hard woody shell or endocarp of about three-tenths of an inch in thickness and very difficult to crack. Within the endocarp is the kernel, having the appearance of a large nutmeg and containing from 40 to 60 per cent of valuable oil. Previous attempts to extract the oil on a large scale have not been very successful owing to the difficulty of breaking the hard shell without crushing the kernel, but this problem appears now to have been solved and it is believed that an industry of considerable proportion will develop in the region where the cohune grows most abundantly. It has been estimated that there are about 25 cohune palms to the acre in British Honduras. A tree yields 1000 nuts annually and about 100 nuts are required to yield a quart of oil. At this rate every acre is capable of producing 250 quarts of oil a year, or approximately 275,000 tons for the whole of British Honduras, while Guatemala and Spanish Honduras probably could each produce a much greater quantity.

The Brazilian "piassaba" or Venezuelan "chiquichiqui," *A. funifera* Mart., is very widely distributed in northern South America along all rivers and in swampy land. While the piassaba produces even larger fruits than the cohune, they are not used for the oil in the kernels, but the so-called nuts which have a much thicker shell were formerly shipped, under the name of "coquillos," to England, where they were used extensively for turned articles such as bell pulls, the knobs of walking sticks and umbrella handles, and other small articles. The fiber obtained from the lower part of the petioles of the younger leaves is exported in considerable quantities to England and the United States.

The "corozo gallinazo" of Costa Rica or "palma real" of Panama is the *Attalea gomphococca* Mart. It is a tall palm producing large bunches of fruits which are smaller than those of the cohune. The "urucuri," *A. excelsa* Mart., is a stately palm within the rubber-producing districts of Brazil where the fruits are burned for the purpose of smoking rubber.

COCOS

There are said to be 36 species of this important genus, but many of these are unimportant and others may prove to be mere varietal

forms of the principal species, *C. nucifera* L., which produces the bulk of the coconuts of commerce. The best authorities on palms are pretty well convinced that *Cocos* is of American origin. Since the fruits will float in salt water for months without injury it is probable that they were carried by ocean currents from South America to the South Sea Islands, and thence eastward, until now the coconut tree is one of the most widely distributed plants in the world, thriving, as it does, along all seacoasts 25 degrees north and south of the Equator.

The coconut tree attains a height of 60 to 100 feet and a diameter of one or two feet. As a rule it grows in regions where it is exposed to the full sweep of the wind from the ocean, but it is so firmly anchored and so flexible as to be able to withstand the severest gales. Coconut trees are usually planted 30 by 36 feet. The largest nuts which ripen on the trees and fall of their own accord are usually chosen for seed. Such nuts are half buried in the soil of the nursery with the "eyes" up. When the young plants are about two feet in height they are transplanted to their permanent sites and begin to bear the fifth year, though it is not until the sixth or seventh year that they give good returns. A coconut tree seldom bears for more than 25 years, although it may live from 60 to 80 years. As a rule a coconut tree produces a bunch of from six to 12 nuts each month and the average annual yield of an acre of land is about 2500 nuts.

Many tons of coconuts are imported into this country annually and in addition to this about 20,000,000 pounds of copra or the dried "meat" (endosperm) obtained from the inside of the hard horny shell. Copra contains from 50 to 63 per cent of oil which is used in such a great variety of ways that there is hardly any limit to the amount that can be utilized. It is produced in practically all tropical countries and shipped to the United States, England, and continental Europe for the preparation of food and technical products.

The fibrous outer husk of the fruit is removed, dried, and prepared for the market under the name of "coir." The bulk of the world's supply comes from Ceylon and is used extensively for making ropes, mats, and cushions as well as for brushes and brooms; it is said that the best coir is made from unripe nuts, but very little of this reaches the markets. In the Philippine Islands the husk of the coconuts is used for fuel in drying the copra. The wood of the coconut tree is esteemed locally for piling as it is resistant to marine borers and is, therefore, a favorite material in making sea defenses. Formerly it was shipped to the English market for making turned articles such as umbrella handles and walking sticks, and was known as "porcupine wood."

Photo by Abrams.

Coconut Grove on Island of Tobago.
(*Cocus nucifera.*)

Photo by S. J. Record.

Royal Palms and Dwelling Built Entirely from Their Products, Cuba.
(*Oreodoxa regia.*)

COPERNICIA

This genus consists of about six species distributed from Mexico southward to Argentina, but the only one that deserves mention here is *C. cerifera* Mart. which supplies the "carnaúba wax" of commerce. It occurs along rivers and the edges of marshes and ponds, and in the south of Brazil and the Chaco country of North Argentina and Paraguay, it forms extensive forests. It is called "carandá" in upper Paraguay. The wax-gathering industry is located chiefly in Parahyba, Ceará, Rio Grande del Norte, Piauhy, and neighboring states. The palm thrives best on areas near the coast where the soil is often slightly saline. Like most other plants growing in locations considered physiologically dry, it can stand drought to a remarkable degree. There are many dry and more or less upland places in Brazil and other tropical countries where this useful palm might be grown with profit.

Carnauba wax is produced chiefly by the young leaves which, when about to unfold, are coated with a thin glossy film of it. The best quality is obtained from the tenderest leaves which are gathered three times during a season. Each tree furnishes about six leaves at each cutting, and about 600 leaves are required to make a pound of first-class wax.

After the leaves have been gathered and graded they are allowed to dry in the sun for several days, after which they are thoroughly beaten with flails so as to remove all the particles of wax from the surfaces. The wax is then put into a tin or earthenware receptacle half full of boiling water and the resulting liquid mass is strained through coarsely-woven cotton cloth to remove the foreign matter. The product soon dries and becomes harder than beeswax. Because of its color, it has not been considered suitable for making first-class candles in Brazil, but has always found many uses in Europe where it has been an article of trade for over one hundred years. The first substantial shipments were made from the state of Ceará in 1845 and for a long time after this it was called Ceará wax. The exports from Brazil, chiefly to England, gradually increased until 1872 when the total quantity amounted to 2000 tons. The annual trade now averages about 2500 tons, and two-thirds of it comes to the United States for use in making cylinders for phonograph records. When bleached it is used for giving firmness to candles and adding brilliancy to the flame. It is used also as an ingredient in leather and hard floor polishes.

The wood from the long slender trunks is very hard and heavy, and because of its great strength and toughness is preferred for roofing, both as beams and rafters, and as laths upon which to support the tiles.

The wood is used locally as well as in Europe and the United States for walking sticks and umbrella handles.

OREODOXA

Most important and best known of the several species comprising this genus is the royal palm or "palma real," *Oreodoxa regia* H. B. K., which grows naturally or is cultivated throughout tropical America. It is at its best in Cuba, where it is one of the most conspicuous and beautiful features of the landscape. (Plate XXI.)

The trunks look like tall pillars of cement, usually swollen at the middle, and bearing at the top a giant tuft of plume-like foliage attached to the shaft with a long bright green cap. The trees grow in all kinds of soil from swamps to hilltops, though naturally they make their best development in rich ground. They are wind-firm and stable, and stately avenues of them all unprotected have endured the storms for generations without a loss.

The royal palm is almost indispensable to the natives, and every portion of the tree finds a use. The leaves are especially useful, and cutting them from the top of the lofty trunk calls for skill and daring. The climber seems to think nothing of it, however, and by means of two loops of rope makes his way quickly to the crown and harvests his crop. The giant leaves consist of three parts, the basal sheath or "yagua," the thick flattened stems, and the plume-like blade or frond. The latter supply the roofing material with which the poorer classes in country and small villages thatch their houses and barns. They are also made into fences, and serve as shade over the tobacco fields. Large quantities are used in closing the ends of the bags filled with charcoal, the all-important domestic fuel in the cities. The leaf stems make good firewood. The sheath is large and flexible like leather, and finds unlimited uses. It is the universal siding for the thatched hut, being set on end and held in place by means of horizontal wooden cleats or poles tied to the house posts. The yagua is the farmer's wrapping paper and tobacco is bundled in it. It can be folded up like birch bark into receptacles for washing clothes, boiling water, and cooking. The inner surface is covered with a thin white layer like parchment which can be peeled off in large flakes and used for writing paper or for rolling cigarettes. Narrow strips torn from the edges are used for cordage.

The fruit is a small hard nut, about the size of a cherry, borne in clusters and there are three stages from the flower to the ripe fruit on the tree at a time. The clusters of mature fruit are gathered, the nuts fed to the hogs, and the finely divided tough stalks tied into bunches

for brooms. In Brazil, an edible oil known as Pará butter is obtained from these nuts. The terminal buds suggest young cabbage and are relished as a salad or when cooked.

The inside of the trunk is loosely fibrous or hollow, but there is a thick outer casing that is very hard and strong, and produces valuable material for buildings and bridges. It is also made into walking sticks and fancy articles and takes a beautiful polish. The hard strands which run through it, in the familiar manner of a cornstalk, show on the surface like the quills of a porcupine. End sections show these strands as conspicuous dark dots and thin layers are much used for special designs in marquetry.

Division II. Dicotyledons

4. SALICACEAE

The Willow Family consists of two genera, *Populus* and *Salix*, each with species widely distributed over the world, but mostly in temperate regions of the northern hemisphere. The poplars or cottonwoods and the willows are among our commonest and best known trees and are alike in having light and soft woods, some of which are of high economic importance.

As to the minute anatomy: The vessels have simple perforations, and the intervascular pits are rather large and their borders are usually polygonal, due to crowding. The rays are mostly uniseriate and are homogeneous in *Populus* and heterogeneous in *Salix;* the pits into the vessels are very distinctive, being numerous, crowded, simple, and of the size of the bordered intervascular pits. The wood fibers have simple pits. The growth rings are terminated by a narrow layer of wood parenchyma.

POPULUS

The poplars or cottonwoods are not tropical trees and their natural range in the region under consideration is limited mostly to northern Mexico, although two or three species extend southward to the City of Mexico. Most of the ten known Mexican species are found also in the United States and at least three of these extend northward into Canada. In Mexico, where they are commonly known as "alamo," they occur mostly along streams and are at their best at lower altitudes where some of the trees reach a height of 100 feet or more with a diameter as great as six feet. The aspen, known locally as "alamillo," is usually a small slender graceful tree, rarely attaining a height of 50 feet and a trunk diameter of 24 inches. Some of the European species are culti-

vated in central and southern Mexico for shade purposes. The wood of *Populus*, so extensively used in the United States for lumber and paper pulp, finds only local employment in Mexico for construction of small buildings, carts, water troughs, fuel, and in the dry regions for fencing material.

Various European and North American species of *Populus* have been planted in South America, particularly in Chile and Argentina. Throughout the latter country the "alamo" or "chopo," *P. nigra* L., and the "alamo de la Carolina," *P. deltoides* Marsh., are commonly grown for shade trees and also in plantations, and the wood finds many local uses such as for boxes, general carpentry, light construction, fuel, and to a limited extent for paper pulp.

SALIX

There are upward of 200 species of willow, and while most of them occur in temperate climates there are representatives in the arctic regions and also in the tropics. They are mostly shrubs and small trees, comparatively few attaining large dimensions. They are extensively planted for decorative purposes and certain species are propagated for their flexible, tough shoots or branches used for baskets and wicker furniture. The bark is rich in tannic acid and is sometimes employed in tanning. Both bark and leaves yield a bitter principle (salicin) which was widely used as a febrifuge before quinine came into general use. A willow decoction is still a common domestic remedy throughout the tropics for ailments of man and beast. The leaves and twigs provide forage for stock, but it is said that when the llamas of Argentina feed upon them they get sore mouths. The usual name for willow in Spanish-speaking countries is "sauce" or "sauz."

There are at least 17 species of willow growing naturally in various parts of Mexico, mostly along the edges of streams. With the exception of our common black willow, *Salix nigra* Marsh., which sometimes attains large dimensions, they are shrubs or only small trees. The wood is used chiefly for fuel and to some extent for construction. The weeping willow, *S. babylonica* L., is planted in parts of tropical America for shade and decorative purposes, and the trees contribute considerable material in the aggregate for general carpentry, boxes, benches, shelves, handles of small tools, oars, canoes, charcoal, and fuel.

One species, *S. Humboldtiana* Willd., occurs naturally in Mexico, Central America, and much of South America. Whitford[8] says: "Travel-

[8] Whitford, H. N.: Forest Conditions of Colombia and Venezuela, *Bull. Pan. Am. Union*, Apr., 1918, p. 468.

ing along the Magdalena River there are places that remind one of traveling along the Ohio or Mississippi River except for the alligators basking in the sun on the edge of the stream and the unfamiliar sight of the tropical high jungle back of it. This is due to the presence of the famous willow (*Salix Humboldtiana*) that is a common feature of the depositing side of the river. In its native habitat it is a shrub or small tree, and groves of it look exactly like groves of willow that grow in similar places along many North American rivers. Carried to the valleys of the high mountains the tree assumes an entirely different form and looks not unlike the Lombardy poplar. It is usually planted in rows along streams, irrigating ditches, and the edge of fields. It is used for light construction purposes, fuel, and for making boxes."

THE WOOD

Salix Humboldtiana Willd. *Sauce colorado.*

Common names: Sauce colorado, sauce común, sauce criollo (Arg.); sauce, sauz, sauz blanco (Mex.); sauce (Salv., Peru); salgueiro do matto (Braz.). OTHER SPECIES: Sauce, sauz, taray, taray del río, tarais, ahuejote, huejocote, huexotl, tepehuexote, yaga-gueza, yutnu-nuu (Mex.); oeirana, salgueiro, chorão (Braz.); sauce, sauce del país (Cuba).

General properties: Color dull gray with a reddish hue. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Wood light and soft, but firm. Sp. gr. (air-dry) 0.44. Weight about 27 lbs. per cu. ft. Grain straight or fairly so. Texture rather coarse. Wood easy to work, tough and strong for its weight, is not durable.

Growth rings: Present, but not very distinct; due to slight differences in density and also to parenchyma.

Parenchyma: In indistinct narrow band limiting growth ring.

Pores: Small, but readily visible; open; very numerous and crowded; well distributed; occurring singly or in small radial groups; sometimes with irregular tangential arrangement.

Vessel lines: Appearing as very numerous fine scratches; sometimes producing a pattern on tangential surface suggesting elm (*Ulmus*).

Vessel contents: None observed.

Rays: Minute; invisible without lens and indistinct or invisible with it on cross and tangential sections; visible, but low and inconspicuous, on radial surface. Cells large enough to be seen with good hand lens on radial section and show rays to be heterogeneous.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Resembles our common black willow, *S. nigra.*

Material: Yale Nos. 1060*, 1067, 6230 (Arg.). Asterisk indicates botanical material.

5. JUGLANDACEAE

The Walnut Family furnishes some of the most valuable and useful timbers in the world. Of the five genera, the best known are *Juglans* (walnut) and *Carya* or *Hicoria* (hickory). Certain species and varieties of these two are also noted for the excellence of their nuts and are propagated extensively on this account. Hickory is largely confined to the eastern half of the United States with limited extensions into southern Canada and northern Mexico; it does not grow naturally in the tropics. *Engelhardia*, *Platycarya*, and *Pterocarya* are Asiatic genera of this family, but the trees, though often of large size, are of little economic value. One species of *Engelhardia* is credited to Central America, but there is no further information at hand concerning it.

JUGLANS

Botanists have described about 50 species of which the best known timber trees are our native black walnut, *Juglans nigra* L., and the butternut, *J. cinera* L., while the English or Persian walnut, *J. regia* L., is cultivated for its nuts, especially in California. The latter species is widely distributed in southern Europe and parts of Asia and is the source of valuable cabinet wood variously known to the trade as Circassian, Persian, Turkish, Italian, and French walnut. This tree is propagated in the Andean region and also in southern Brazil.

The wood of *Juglans* exhibits considerable variation in color and in weight, the two extremes being illustrated by our black walnut and butternut. The walnut is not typically a tree of the tropics and its occurrence in tropical America is limited to the mountainous regions. Its range includes Mexico, the Andes Mountains from Argentina to the Cordilleras, and portions of the West Indies. The woods of the West Indian species, so far as studied, are of the butternut type, while the others are in the black walnut class, though some of them are rather soft.

Juglans jamaicensis C. DC. occurs at high elevations in Porto Rico and certain other portions of the West Indies and is sometimes 80 feet tall and 24 inches in diameter. *J. insularis* Gris. has a limited distribution in Cuba. Both of these are of only minor importance. There are several species in Mexico, some of which are said to attain rather large dimensions in favorable sites, particularly on the lower slopes of the western Sierras, but the walnut timber entering the trade from these regions is in small sizes resembling hewn railway ties and is brought out of the forest on pack animals.

Walnut grows naturally in the Cordilleras of Colombia and probably also in Venezuela. One species yields a wood of beautiful satiny luster and deep brown color, more or less variegated. Both tree and wood, except for the color of the latter, suggest Spanish cedar, and the tree is sometimes referred to as "*Cedrela Nogal*" and the wood is commonly known as "cedro negro." The specimen in the Yale collection (No. 399) from Medellin has the characteristic walnut taste and the parenchyma is in numerous, fine, irregular, and broken lines scarcely distinct with a lens. It certainly is not *Cedrela* (Meliaceae), but it is not typical of *Juglans* either. A specimen of "nogal" from Bogotá (Yale No. 386) has the typical walnut structure described below. It is supposed to be *J. colombiensis* Dode. Both woods have about the same density; sp. gr. (air-dry) 0.55 to 0.57.

The principal Peruvian species is *Juglans neotropica* Diels, and, in the mountain valleys, it becomes a stately tree upward of 100 feet high and two to three feet in diameter, with a dark-colored, moderately hard wood, valued for cabinetwork. The Argentine species, *J. australis* Gris., is found in considerable quantities in Tucumán, Salta, Jujúy, and Santiago del Estero. The trees are mostly short, generally under 60 feet, but with thick trunks sometimes exceeding three feet in diameter. The wood is lighter in weight than native black walnut, but otherwise closely resembles it and has the same uses. The bark and the sawdust are used locally as a source of dyestuff for giving a peculiar brown or coffee color to cloth.

THE WOOD

Juglans australis Gris. *Nogal.*

Common names: Nogal, nogal cayuré or cayurí, nogal cimarrón, nogal criollo, nogal silvestre (Arg.). Other species (tropical America): Nogal (Span., general); nogal del país (Cuba); palo de nuez (P. R.); cedro negro (Col.); Jamaican or West Indian walnut (B. W. I.).

General properties: Deep reddish-brown or chocolate; somewhat variegated; somewhat lustrous. Sapwood gray; sharply defined in old trees.

Taste mild, but distinctive. Odor of fresh wood distinctive.

Rather light and soft. Sp. gr. (air-dry) 0.56. Weight about 35 lbs. per cu. ft. Grain mostly straight. Texture medium. Wood easy to work, holds its shape, takes high polish, is fairly strong and durable.

Growth rings: Fairly distinct; due to slight differences in density and in color, the late wood being of lighter shade than early wood.

Parenchyma: In numerous fine wavy concentric lines, not always evenly spaced; visible without lens. Some of the cells show as white dots under lens.

Pores: Variable from rather large and distinct to small and indistinct; not very numerous; irregularly scattered; occurring singly or sometimes appear-

ing as though subdivided radially; usually partially filled with lustrous tyloses.

Vessel lines: Very distinct as long deep grooves.

Vessel contents: Tyloses rather abundant; very dark and lustrous.

Rays: Fine, but distinct, on cross section; faintly visible on tangential, visible but inconspicuous on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations. Rays mostly homogeneous; one to five cells broad and few to 30 cells high; pits into the vessels simple or slightly bordered, numerous but not crowded, mostly elliptical. Parenchyma is in uniseriate concentric lines; crystals common. Wood fibers have bordered pits; terminal rows of fibers much flattened.

Remarks: The pith of *Juglans* is chambered.

Material: Yale Nos. 898, 1137, 4396, 6202 (Arg.).

6. BETULACEAE

The Birch Family is confined almost entirely to the northern hemisphere. It contains six genera, five of which are well known in the United States. The most important is the birch, *Betula*, which supplies large quantities of valuable lumber in the United States. The blue beech, *Carpinus*, the hop hornbeam, *Ostrya*, and the alder, *Alnus*, are small trees or shrubs, of relatively small commercial importance, while the hazelnut, *Corylus*, is a mere shrub valued chiefly for its nuts which are known on the market as filberts.

The three genera represented in regions south of the United States are *Alnus*, *Ostrya*, and *Carpinus*. The Mexican species of *Carpinus* is the same as our blue beech, *C. caroliniana* Walt., and is known locally as "lechillo," "palo silo," or "palo barranco." It attains a height of 35 to 40 feet and a diameter of two feet and has the characteristically fluted trunk. The wood is used mainly for fuel and charcoal.

Ostrya guatemalensis Winkl. of Mexico and Central America is a small tree rarely as high as 50 feet, with a very hard, fine-textured, tough, and fairly durable wood used to some extent for cross-ties, tool handles, implements, and for fuel. The bark is utilized locally in tanning and dyeing. The Mexican name for this tree is "guapaque."

ALNUS

There are several alders in Mexico, Central America, and Venezuela, and one, *Alnus acuminata* H. B. K., is found in the Peruvian Andes. They vary in size from shrubs to small or medium-sized trees, although *A. glabrata* Fern. is said to become a large tree under favorable conditions.

The bark of the alders is rich in tannin and is used in Mexico for tanning skins, producing a red leather, and also for dyeing purposes. Both bark and fruit are employed medicinally. There is no information available regarding the uses of the wood, but the fact that the Yale collections contain a specimen (No. 4368) obtained at a sawmill in Santa Rosa, Costa Rica, indicates that some alder lumber is produced. According to Herrera[9] the wood is highly esteemed in Peru and is employed in all kinds of construction work.

THE WOOD

Alnus sp. *Jaul.*

Common names: Jaul, alum ? (C. R.); aile, ayle, abedul, aliso, olmo del país, palo de águila, yaga-bizie (Mex.); palo de lama (Guat.); aliso, lambrán (Peru).

General properties: Color very light brown with a pinkish tinge; surface of freshly cut wood soon becomes yellowish-brown or bronze upon exposure. Sapwood not very distinct.

Odor and taste absent or not distinctive.

Rather light and soft, but firm. Sp. gr. (air-dry) 0.47. Weight about 29 lbs. per cu. ft. Grain straight. Texture rather fine, about the same as willow (*Salix*). Wood easy to work, tough and strong for its weight, finishes smoothly, is not durable in contact with the ground.

Growth rings: Fairly distinct; due to narrow zones of deeper color.

Parenchyma: Not visible.

Pores: Very fine, but visible; open; numerous, but not crowded; well distributed; occurring mostly in radial groups of two to several.

Vessel lines: Fine and inconspicuous. Scalariform perforations with numerous bars can sometimes be made out on radial surface with good hand lens.

Vessel contents: None observed.

Rays: Extremely fine; not visible on cross or tangential sections without lens and not very distinct with it; visible, but fine and inconspicuous, on radial surface, appearing somewhat darker than background. Large aggregated rays, such as are common in some species, apparently absent.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with scalariform perforations with few to many bars. Rays one or two cells wide; homogeneous; pits into vessels half-bordered. Wood parenchyma scanty and diffuse. The wood fibers have bordered pits.

Remarks: The wood closely resembles that of the red alder, *Alnus oregona* Nutt., of northwestern United States.

Material: Yale Nos. 4368 and 4369, collected in Costa Rica by Professor Rowlee of Cornell University; his Nos. 47 and 49.

[9] Herrera, Fortunato L.: *Contribuçion a la flora del Departmento del Cuzco,* 1921, p. 76.

7. *FAGACEAE*

The Beech Family consists of six genera and over 400 species of trees and shrubs occurring chiefly in temperate regions. To this family belong the beeches, the oaks, and the chestnuts, some of the best known and most important timber trees of the world. Five of the genera, namely, *Fagus*, *Castanea*, *Castanopsis*, *Pasania* or *Lithocarpus*, and *Quercus*, occur in North America, the other, *Nothofagus*, contains the Antarctic beeches of Chile, Patagonia, and New Zealand.

QUERCUS

There are over 100 different kinds of oaks, both trees and shrubs, in Mexico and Central America, one or two in Colombia, and one in Cuba. The center of distribution is Mexico, and more species are found there than in any other country. In northern Mexico the trees are found at comparatively low altitudes in the arid mountains and also at high altitudes in the larger ranges such as the Sierra Madre, while in the south they are mostly confined to the high mountains, though a few occur near sea level. Many of the northern species are the same as found in southwestern United States. The tropical American species are about equally divided into two main groups, namely, (1) deciduous with ring-porous woods, and (2) evergreen or live oaks with diffuse porous woods. There are no essential differences between the oak woods of the United States and those south of its boundaries. The most conspicuous structural feature of the wood is the large rays which show so prominently on quarter-sawn (radially cut) lumber. The timber is much used and highly esteemed locally and some is exported from Mexico, principally for furniture and interior trim.

Common names: Roble, encina or encino (Sp. Am., general); aguatle, ahoaquahuitl, ahoatl, ahuatl, aoatl, camay-cuy, charrasquillo, palo colorado, palo duro, manzanilla, maquilihuatl, mêttza, sho, shokiup, roblecito, tarecuen, texmole, tnu-yáa, tnu-yaha, yaga-cino, yaga-reche, yaga-xoo, yaga-yoo (Mex.); bellota, roble encino, roble negro (Salv.).

Material: Yale Nos. 50 (Hond.); 389 (Col.); 816 (Cuba); 3716*, 3717* (Guat.); 4403*, 4404*, 4408* (Mex.). Asterisk indicates botanical material.

NOTHOFAGUS

The Antarctic beeches are confined to Chile and the Patagonian region of Argentina of the western hemisphere, and to New Zealand, Tasmania, and southeastern Australia of the Old World. Some of the South American species attain large dimensions and grow in dense forests over great

areas. The lumber is highly esteemed locally for cooperage and for all kinds of carpentry, general construction, and shipbuilding. The woods vary in density, but are firm and strong, straight-grained, of fine and uniform texture, easy to work, and finish smoothly. Unlike the northern beeches, they have no large rays and are of much the consistency of birch (*Betula*) or cherry (*Prunus*). The prevailing color is a pale red or cherry. Growth rings are fairly distinct, due to narrow zones of somewhat greater density than the remainder.

As to the minute anatomy: The perforations of the vessels are predominately simple, although occasionally scalariform with rather numerous anastomosing bars. The rays are one or two cells wide and few to 40 cells high; heterogeneous; the pits into vessels are simple or indistinctly half-bordered, rather large, horizontally elongated, opposite or in scalariform arrangement. Wood parenchyma is sparingly developed, diffuse, or in small tangential groups among the flattened wood fibers terminating growth rings; crystals are common. The pits in the wood fibers are minute and simple.

Common names: Roble, roble de Magellanes, coigüe, coyan, guindo, hualle, pellin, rauli (Chile); roble, roble cienego, coihue, cohigüe, coyán, lengue, ñire (Arg.); beech, South American beech, Antarctic beech (Eng.).

Material: Yale Nos. 967, 968, 969, 1102, 1765, 4133, 4393 (Arg.); 2046, 3755, 3756, 3763, 5545, 5554, 5555 (Chile); 5130, 5136, 5141, 5146, 5290, 6599 (New Zealand).

8. ULMACEAE

The Elm Family consists of about 13 genera and 150 species of trees and shrubs of extensive distribution in temperate and tropical regions. There are five genera in tropical America, and two of these, *Ulmus* and *Celtis*, together with the non-tropical *Planera*, occur in the United States.

ULMUS

The members of this genus, the elms, are among the finest shade trees in temperate regions, and also supply tough and strong woods of great usefulness. The only species in tropical America is the Mexican elm, *Ulmus mexicana* Planch. (= *Chaetoptela mexicana* Liebm.), a deciduous tree, sometimes 100 feet high and over three feet in diameter, growing in the lower mountain regions from Vera Cruz and Oaxaca, Mexico, southward to Panama and northwestern Colombia. In part of its range it is an important element of the forests and is sometimes met with in nearly pure stands of considerable extent. The wood is rather hard, heavy, tough and strong, but is rarely utilized because of its inaccessi-

bility. It has the typical elm structure, a single row of comparatively large pores in the early wood and very small pores arranged in wavy tangential lines or festoons in the late wood. The vessels are not marked with spirals as in most species of *Ulmus*. The color of the heartwood is a deep reddish-brown, often with darker streaks, and the thick sapwood is a light brownish-gray. The common names are: Mexican elm (Eng.); olmo, papalote, cempoalehuatl (Mex.); ira (C. R.); ceniza, cenizo (Pan.).

Material: Yale No. 3006, collected by Dr. Pittier in Panama; his No. 2938.

TREMA

There are many species of this genus in the tropics of both hemispheres, but they are only shrubs or small trees. The best known and most widely distributed species is *Trema micrantha* (L.) Blume, a shrub or sometimes a tree 50 feet high and 20 inches in diameter, occurring in the West Indies, southern Florida, and from Sinaloa, Mexico, southward through Central America to Brazil and Argentina. It is sometimes used to shade cocoa and other plantations, the supple twigs are woven into baskets, the bark supplies a very strong fiber for cordage, and the soft, white, brittle wood is used chiefly for charcoal for gunpowder.

The wood structure is in many ways different from *Ulmus* and *Celtis*. The pores are very small, scattered or in radial groups of two to five. The vessels do not have spirals. The rays are very narrow and inconspicuous; heterogeneous; the pits into the vessels are irregular, often much elongated horizontally, simple to half-bordered. The fibers are thin-walled and have simple pits. Parenchyma is very scantily developed.

Common names: Guacimilla, guazymillo, palo de cabra (P. R.); pain-in-back (Bah.); bass cedar, Jamaican nettle tree (Jam.); memiso (S. D.); masaquila (Venez.); ixpepe, equipal, capulín, jucó, vara blanca, yaca de cuero (Mex.); capulín, capulín macho, capulín montes, capulincillo (Salv.); venaco (Col.); coatindiva, crindeuva, páo de polvora (Braz.); palo pólvora, fruta de paloma, ingá-morotí, ingá blanca, afata colorada (Arg.).

Material: Yale Nos. 4844*, 4860* (Haiti). Asterisk indicates botanical material.

CELTIS

This genus includes our common hackberry, *Celtis occidentalis* L., and many other species of shrubs and trees widely distributed over the world. There are six species in Mexico, but only the "palo blanco" of the north, *C. mississippiensis* Bosc., which is the same as the sugarberry of the southern United States, attains very large dimensions. Its timber

is used in Mexico for the manufacture of carts and for miscellaneous minor purposes. The wood of some of the other Mexican species is used for posts, tool handles, and implements. There are several species in the forests of Argentina; one of these, the "tala," *C. Tala* Gill., attains a height of about 50 feet and a diameter of 20 inches, and produces a wood used for carpentry, vehicle bodies, tool handles, whip-stocks, screen frames, and miscellaneous purposes requiring a strong and tough material.

THE WOOD

Celtis Tala Gill. *Tala.*

Common names: Tala, chusquitala (Arg.). Other species: Tala blanca, tala crecida, tala arbol, tala ema, tala pispa, tala trepadora, yoá-sỳ-y (Arg.); gurupiá (Braz.); berraco (Col.); uña de gato, zarza (Cuba); gallito (S. D.); acibuche, capul, cumbro, garabato, garabato blanco, grangeno, granjeno, granjeno huasteco, palo blanco, palo de aguila, palo duro, palo mulato (Mex.); duraznillo (Salv.); cagalera comestible (Nic.).

General properties: Color yellow or yellowish to grayish. Sapwood nearly white; not clearly defined; subject to blue stain.

Odor and taste absent or not distinctive.

Hard and heavy to moderately so. Sp. gr. 0.60 to 0.85 (Castro). Weight 37 to 53 lbs. per cu. ft. Grain fairly straight to irregular. Texture medium to coarse. Wood tough and strong; fairly easy to work; is not very durable.

Growth rings: Absent or indistinct. When present due to more orderly arrangement of elements and to occasional wider and more distinct fiber bands between parenchyma layers.

Parenchyma: Abundant, very distinct; in wavy concentric bands of irregular width; including pores; distinct on longitudinal surface, producing distinct pattern on the tangential.

Pores: Small; visible, but not very distinct; fairly numerous; mostly in groups as though subdivided radially two to several times.

Vessel lines: Fine; distinct to indistinct.

Vessel contents: Tyloses present, some white substance noted.

Rays: Fine, but visible, on cross section; invisible on tangential; distinct, but not conspicuous, on radial surface where they appear darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits large, crowded; no spirals observed. Rays heterogeneous; one to seven cells wide and few to 40 cells high, widely variable; crystals common; pits into vessels rather large, irregular, half-bordered. Parenchyma abundant. Fibers have simple pits.

Remarks: Distinguished from *Ulmus* by the fact that in the latter the rays are homogeneous.

Material: Yale specimens Nos. 1002, 1006, 1031, 3416*, 6212 (Arg.).

PHYLLOSTYLON

The only species, *Phyllostylon brasiliensis* Capanema,[10] occurs in Argentina, Brazil, Cuba, Haiti, Venezuela, and Mexico. It is an important tree in Argentina, where it attains a height of 50 feet and a diameter of 30 inches, and furnishes excellent wood for agricultural implements, furniture, and house construction.

In Mexico, the tree, known locally as "seron" or "cerón," is said to be of common occurrence in the southern part of Tamaulipas and portions of San Luis Potosi and Hidalgo which form what is commonly called La Huasteca. The tree reaches a diameter of two feet or more.[11]

Regarding the occurrence of this tree in eastern Cuba, Mr. G. C. Bucher of Santiago writes as follows: "The 'jatía,' as it is called here, occurs on the south coast in this province, growing in almost solid stands on the coastal plains. The largest stand that I have observed is around the mouth of the Guantanamo River. There is another large one at the head of the bay, and another in the lower Gateras Valley. It is very rarely seen in the interior of the island, that is, after passing the first range of hills from the coast. Its principal use here is for firewood for the sugar mills near the coast, and is not even considered a very good wood for charcoal."

In Haiti, where it is known as "bois blanc," it is the most common tree in the dry calcareous soil of the flat and arid regions south of Gonaives. It often grows gregariously in open stands and is of poor timber form, but it occurs in mixture with other trees and is then of better proportions, being 18 to 20 inches in diameter and free of limbs for upward of 30 feet. The timber is used locally for fence posts and building construction, but only the smaller sizes are employed, the larger trees being rarely cut except to clear the land.

In Santo Domingo, this tree, known usually as "baitoa," is common in the valleys of the Yaque del Norte and the Yaque del Sur and also on the low dry foothills and lower mountain slopes, attaining a diameter of 20 to 24 inches and a height of from 50 to 70 feet. The timber has been introduced in limited amount into the New York market under the name of San Domingan boxwood. The logs, which are from eight to 20 inches in diameter and 10 or 20 feet long, are irregular and likely to be more or less fluted or "in-barked." The more prominent irregularities are usually hewn off before shipment. The wood is unsuited for engrav-

[10] = *P. rhamnoides* Taub. = *Samaroceltis rhamnoides* Poisson.

[11] For this information the authors are indebted to Mr. Arturo M. Garcia, of Monterey, N. L., Mexico, who also supplied leafy twigs, wood samples, and a photograph of the tree. There is a fruiting specimen, collected by Pringle in San Luis Potosi, in the U. S. National Herbarium at Washington, D. C.

Photo by H. M. Curran.

The Humboldt Willow, Argentina.

(*Salix Humboldtiana.*)

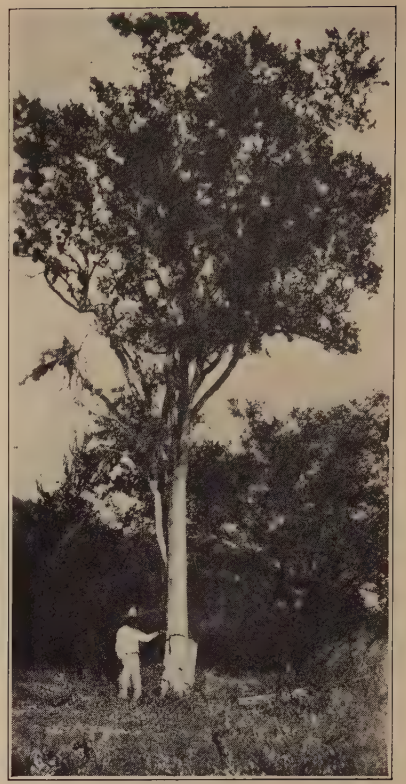


Photo by A. M. Garcia.

The Seron of Southern Mexico.

(*Phyllostylon brasiliensis.*)

PLATE XXII

ing and its principal use is for weavers' shuttles, though it is also employed to some extent for rulers and for piano keys.

THE WOOD

Phyllostylon brasiliensis Cap. *San Domingan Boxwood.*

Common names: San Domingan boxwood (Trade); baitoa, bois blanc (S. D.); bois blanc (Haiti); jatía (Cuba); seron, cerón (Mex.); páo branco (Braz.); ibirá-catú, palo lanza negro, yaó-si-y-guazú, tala grande, palo amarillo, palo blanco (Arg.); membrillo (Venez.).

General properties: Color deep clear yellow to very pale brown with a thin layer of white or colorless sapwood. Liable to blue or brownish stain if improperly seasoned.

Odor and taste absent or not distinctive.

Heavy, hard, compact. Sp. gr. (air-dry) 0.95. Weight about 59 lbs. per cu. ft. Texture very fine and uniform. Grain straight or fairly so. Wood easy to carve and turn; takes a high polish.

Growth rings: Sometimes fairly distinct; due to more orderly arrangement of the elements at intervals and sometimes also to fine line of terminal parenchyma.

Parenchyma: Scarcely distinct without lens; about pores and pore-groups and connecting them into irregular tangential lines.

Pores: Very numerous, small, scarcely distinct without lens, except those containing white substance which are very distinct.

Vessel lines: Fine and inconspicuous, except those containing white substance which are distinct.

Vessel contents: Many vessels filled with calcium carbonate, showing plainly on all sections. The effervescence produced upon application of a drop of hydrochloric acid to the end of a specimen affords a ready means for separating this wood from others of the boxwood class.

Rays: Very fine, but visible on cross section; invisible on tangential; fairly distinct on radial surface.

Ripple marks: Present, but not always distinct even with lens; many of the rays occupy two to three tiers; fairly regular; number per inch, about 140. This is the only wood of the boxwood class possessing ripple marks.

Minute anatomy: Vessels with simple perforations; segments in horizontal seriation (tangential section) with the parenchyma strands and with the low rays; intervascular pits comparatively large, with elongated apertures. Rays heterogeneous; mostly two or three cells wide and one to 40 cells high; high rays usually constricted slightly at junction of tiers (two to five per ray); pits into vessels large, simple to distinctly half-bordered; crystals common. Wood parenchyma in single rows limiting growth rings; usually two cells per strand. Wood fibers with thick gelatinous layer; not in radial rows; pits small, indistinct, simple.

Remarks: The bark, usually present on logs in the market, is thick and resembles that of sugar maple (*Acer saccharum* Marsh). The inner bark

shows on cross section numerous fine wavy rays and very fine concentric lines; also irregular wedge-shaped patches here and there extending from the outer surface to varying depths; the inner surface shows distinct ripple marks.

Material: Small Cuban specimens from herbarium material of N. Y. Botanical Garden and material collected in Haiti by Mr. Mell; also Yale Nos. 782 (Cuba); 971, 1048*, 1690*, 6237 (Arg.); 4456, 4457, 4458, 5023 (S. D.); 5405* (Mex.); 6773 (Venez.). Asterisk indicates botanical material.

9. MORACEAE

The Mulberry Family, consisting of about 70 genera and 1000 species of trees and shrubs, some of them epiphytic, is widely distributed throughout the warmer parts of the world, with a few representatives in temperate regions. Of the latter the best known are the mulberry, *Morus*, the Osage orange, *Maclura* or *Toxylon*, and the edible fig, *Ficus carica* L. Considerably more than half of the known species belong to one genus, *Ficus*. There are over 25 arborescent genera in tropical America, besides a few that have become naturalized through cultivation. The members of the family are characterized by a milky latex which in some instances, especially the species of *Castilla*, is the source of commercial rubber. The leaves of some of the plants serve as forage for livestock and as food for the silkworm; also for medicinal purposes. The best known woods in the trade are fustic, letterwood or snakewood, and the "satiné."

The woods are of two general kinds, (1) light and soft, and (2) hard and heavy. Some of the first group approach balsa (*Ochroma*) in lightness, while the second contains one of the heaviest woods known, namely, snakewood (*Piratinera*). Their structure approaches that of some of the Leguminosae, the most striking example being the close similarity of Osage orange to black locust (*Robinia*). The vessels have simple perforations. The rays are usually fine and never very large, and the pits into the vessels are half-bordered to simple, and often large and elongated. Ripple marks are known to occur only in a few species of *Ficus*. Gum ducts have not been observed, but latex tubes in the rays are common in the woods of many genera. Spiral vessels have been found in woods of *Broussonetia*, *Maclura*, and *Morus*. The wood fibers almost always have simple pits.

CHLOROPHORA

This genus is usually considered as consisting of a single species, *Chlorophora tinctoria* Guad. (= *Maclura tinctoria* G. Don = *Morus tinctoria* L.), although two or three other species have been named and certain varieties are recognized. The wood generally known to the trade

as fustic or old fustic,[12] is one of the most important dyewoods of commerce and its use dates back to the middle of the seventeenth century. The usual Spanish name is "mora."[13]

The fustic tree rarely attains a height over 65 feet and a diameter greater than 30 inches, and is usually much smaller. The latescent bark is of a brownish-gray color and is usually quite smooth on the young trees, though both trunk and branches are sometimes beset with spines. The crown is ordinarily rather open and spreading. The leaves are simple, alternate, entire or toothed, and rarely over four inches long. The female flowers are in little heads, the male in rather long and dense catkins. The fruit consists of dry nutlets surrounded by the persistent parts of the flower.

The tree has an extensive range in tropical America. It occurs abundantly in the lowlands of Mexico and Tampico southward and is more or less common along the east and west coasts of all of Central America; it does not grow on the highlands. It is well known in Colombia, Venezuela, Brazil, and Argentina, but the Brazilian and Argentine kinds are somewhat different, not only in their botanical characters, but also in the dye-producing qualities of their wood.

Regarding the Argentine species, Mr. Curran says: "The 'mora' is a rather tall symmetrical tree with a rather fine-textured and comparatively smooth brown or gray bark and with a fairly narrow crown. The trunks are usually between 18 and 24 inches in diameter, with clear lengths of 40 to 50 feet. Although not abundant anywhere, the tree is a constant factor in the forests of Misiones, Paraguay, and southern Brazil. The timber reaches the market in the form of squared logs, of which the annual consumption in Argentina is probably less than 100,000 board feet. It is used for various purposes where a hard, durable wood is needed, and not as a dyewood. It is well known to the wheelwright and carpenter and also makes good fence posts, props, and fuel. The Indian name for the tree is 'tatayiba,' meaning firewood. Two or three varieties of the trees and woods are recognized."

True fustic has been reported from practically all the islands of the West Indies. It is exploited on some of the larger islands, as Cuba, Haiti, Jamaica, and Trinidad, where it forms an important article of export. The commercial supply of the wood is drawn largely from Campeche and Mazatlan, Mexico, and from Honduras, western Nicara-

[12] The name young fustic is applied to the wood of the smoke tree, *Cotinus Cotinus* (L.) Sarg., a Mediterranean species of the family Anacardiaceae. The wood is ring-porous and without parenchyma lines.

[13] The name "mora" is also applied to a leguminous wood, *Dimorphandra Mora* B. & H. (= *Mora excelsa* Benth.), of British Guiana, Venezuela, and parts of Central America.

gua, western Costa Rica, Panama, and Venezuela, with smaller quantities from the West Indies. The tree attains its best development along the west coast of Central America. It occurs scatteringly, a stand of one or two trees per acre being a fair average; consequently the cost of logging is always high and in the poorly accessible regions is often prohibitive. The trees are chopped down, and the trunks and larger branches cut into lengths of four or six feet and hewn free of sapwood, since only the heartwood is merchantable. The logs ready for market vary in diameter from a few inches to two feet, the largest being considered the best wood. They are hauled or dragged over rough country to the nearest river whence they are taken on small boats to a shipping port. Sometimes it requires two or three days to get an ox-cart load of about a ton from the stump to the river landing.

Fustic is imported usually in the form of logs. These are chipped and the chips ground to a powder which is put into bags ready for the dyer. In this state there is opportunity for adulteration which is difficult to detect on account of the small size of the particles. From the pulverized wood the dyer prepares an aqueous extract and paste or lake. A strong decoction of the wood is of a reddish-yellow color, the yellow becoming more pronounced upon dilution. The coloring principle, maclurin, is readily soluble in water. The chips are often employed for dyeing by keeping them in bags at the bottom of the bath or of the dyeing vat. The natural color thus obtained, without mordants, is a fairly permanent dull yellowish-brown or khaki. The use of mordants permits a considerable range in shade and adds to the permanency of the color. Fustic is also used with other dyewoods for compound shades, such as drab, fawn, olive, etc., and with logwood (*Haematoxylon*) for dyeing black both on cotton and on silk. Although the fustic industry has been very greatly reduced, except during the abnormal conditions created by the war, it is believed that the wood will always be a factor in the world's commerce.

THE WOOD

Chlorophora tinctoria G. Don *Fustic.*

Common names: Fustic, fustick, old fustic, fustic wood, mulberry, dyer's mulberry, fustic mulberry, Cuba wood, yellow wood, mora, mora yellow wood (Eng.); bois jaune, bois jaune de Brésil, bois jaune de Cuba, bois jaune de Tampico, fasteque, fusteque, bois à pian, maclura tinctorial, murier à rameaux epineaux, murier des teinturies (Fr.); fustik, fustikholz, alter fustik, gelbholz, brasilienische gelbholz, Brasilienholz, fiselholz, fisetholz, fustteholz, Jamaikaholz, farber-maclura, farber-maulbeer, farbende maulbeer (Germ.); bastaord yzerhart, stokvischohout, citroenhout, geelhout, verwermorebessen (Dutch); fustete, mora (Span.); legno giallo (Ital.); fustete,

mora de loma, mora de piedra, mora del país, mora blanca, fresno de America (Cuba); mora, palo de mora (P. R.); fustic, bois d'orange, palo naranjo (Trin.); tatajiba, tatajuba de tincta, tayuva, amoreira de espinho, espinheiro branco, limao, runa, páo amarello (Braz.); dinde, palo mora (Col.); mora, mora amarilla, mora colorada, brazo del fuego, tatayibá, tatayibá-pyitá, tatayibá-saiyú (Arg.); amarillo (Boliv.); moral amarillo, moral de clavo, moral liso, moradilla, palo moral, yaga-huil (Mex.); morera, palo de mora, brasil ? (C. R.); palo amarillo, mora (Salv.).

General properties: Various shades of yellow; usually uniform; lustrous; becoming reddish or brownish upon exposure. Sapwood white; about one inch thick; sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy, more or less horn-like. Sp. gr. (air-dry) 0.93 to 0.99. Weight, 58 to 62 lbs. per cu. ft. Grain varying from fairly straight to somewhat interwoven. Texture medium to coarse; fairly uniform. Wood not very difficult to work, finishes smoothly, is tough, strong, and durable.

Growth rings: Variable; sometimes distinct due to peripheral alignment of elements, to parenchyma lines, or to poreless zones.

Wood parenchyma: About vessels and confluent into netted arrangement; sometimes in concentric, more or less wavy, lines or bands; distinct on cross section; also visible on tangential section producing, in proper light, wavy and zigzag patterns. Some specimens have considerably more parenchyma than others.

Pores: Rather small, but distinct on account of the parenchyma; fairly numerous; occurring singly or subdivided radially; linked together by parenchyma into diagonal, tangential, or wavy lines or festoons; no tendency to ring-porous structure.

Vessel lines: Distinct, but not conspicuous; straight and long or alternately long and short. In proper light they appear of lighter color than background.

Vessel contents: Tyloses abundant.

Rays: Barely visible on cross and tangential sections, requiring good light. Distinct on radial surfaces, producing a fine silver grain in proper light.

Ripple marks: Absent.

Gum ducts: None observed. Laticiferous tubes occasionally present in rays.

Minute anatomy: Vessels with simple perforations; tyloses thin-walled. Rays mostly homogeneous; one to five cells wide (rarely wider) and few to 40 cells high; pits into vessels medium-sized to rather large, half-bordered to simple. Fibers in fairly definite radial rows; walls thick; pits small, simple. Parenchyma abundant; crystals of calcium oxalate very common in chambered parenchyma.

Remarks: This wood is somewhat like Osage orange and yellow locust in texture, density, and color, but is not ring-porous. For comparisons with certain other woods see: Sudworth, G. B. and C. D. Mell; *Fustic wood: Its substitutes and adulterants,* Cir. 184, U. S. Forest Service, Washington, D. C., 1911.

Material: Yale Nos. 764, 797 (Cuba); 5052 (S. D.); 417*, 428, 4441

(Col.); 6669 (Venez.); 1465, 3177 (Braz.); 2986*, 4465 (Pan.); 3720*, 3729* (Guat.-Hond.); 31, 111, 122 (Hond.); 5239 (Nic.); 2946, 4474, 4734, 4979 (Mex.); 1104, 1119, 1697*, 3979, 6236 (Arg.). Asterisk indicates botanical material.

BAGASSA

This genus consists of two or three species of trees of the Guianas and northern Brazil, of which the best known is *Bagassa guianensis* Aubl., called "bagasse" in French Guiana and "tatajuba" in Brazil. According to Bertin,[14] the "bagasse" is a tree sometimes 28 inches in diameter, yielding a yellow, durable wood, moderately hard, sp. gr. 0.745, and of good quality for carpentry, joinery, and cabinetwork. Huber (*loc. cit.*, p. 171) says the "tatajuba" is a large tree of the upland forests in the vicinity of Belem, Brazil, and furnishes a dense wood, of a dark yellow or grayish color, with prominent pores, and good for civil and naval construction. The name "tatajuba" is also applied to the fustic tree (*Chlorophora*).

THE WOOD

Bagassa guianensis Aubl. *Tatajuba.*

Common names: Tatajuba, bagaceira (Braz.); bagasse, bagasse jaune (Fr. G.); bois bagasse (Guad.).

General properties: Color lustrous yellow, becoming russet brown superficially upon exposure.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.80. Weight about 50 lbs. per cu. ft. Grain fairly straight to irregular. Texture somewhat coarse. Fairly easy to work, splits readily, takes high polish, is strong and durable.

Growth rings: Absent or sometimes indicated by narrow poreless zones.

Parenchyma: In narrow layer about pores; not in lines; fairly distinct.

Pores: Rather large, very distinct; fairly numerous, but not crowded; fairly well distributed; mostly single, but sometimes subdivided radially two to several times; closed.

Vessel lines: Resembling coarse scratches, appearing lighter than background (in proper light) due to parenchyma sheaths; distinct, but not conspicuous.

Vessel contents: Tyloses abundant.

Rays: Distinct on cross section, faintly visible on tangential, very distinct on radial surface, appearing lighter than background and producing a fine silver grain.

Ripple marks: Absent.

Gum ducts: None observed.

[14] Bertin, A.: Les bois de la Guyane française et du Brésil, *Mission For. Col.*, 5:254-255.

Minute anatomy: Tyloses thin-walled. Rays one to five seriate, few to 35 cells high; heterogeneous, the larger cells often interspersed rather than marginal; pits into vessels half-bordered, rather large and elongated. Fibers with very small pits; walls moderately thick.

Remarks: Has the general appearance of *Chlorophora,* from which it is readily distinguished by the fact that the parenchyma is confined to the vicinity of the pores and is not in lines.

Material: Yale No. 4142 (Braz.); 5367 = Bertin's No. 3005 (Fr. G.).

CLARISIA (SOARESIA)

Little information is available regarding the trees of this genus, of which there are four known species, two in Peru and two in Brazil. The trees are said to be tall, with alternate, entire or spiny-toothed deciduous leaves, fleshy egg-shaped fruits, and a milky latex in the bark.

Clarisia racemosa R. & P. (= *Soaresia nitida* Fr. Allem.) is known as "oitiçica" and sometimes as "oity" in Brazil, though these names are applied also to species of *Moquilea* (Rosaceae). According to Mr. Curran, it is a very common tree in the rain forests of Bahia where it grows scatteringly or in small clumps in association with "páo d'alho" (*Gallesia*), "massaranduba" (*Mimusops*), "araça de agua" (*Terminalia*), and "jequitibá" (*Couratari*). It attains a height of 130 feet and a diameter of three feet, with clear lengths of 50 to 60 feet. It is a well-formed tree, without buttresses, and the bark is covered with small corky warts. The wood is well known to the rural population, but does not enter the market, and is used to a limited extent for general construction and carpentry, but owing to its roe grain, it is not easy to surface smoothly. It does not last very long in the ground and is considered unsuitable for posts or railway ties. When properly finished and stained, the wood resembles mahogany (*Swietenia*).

THE WOOD

Clarisia racemosa R. & P. *Oitiçica.*

Common names: Oitiçica, oitiçica amarella, oity, guariuba (Braz.).

General properties: Color canary yellow, becoming russet or chocolate-brown upon exposure; uniform, though presence of roe grain gives striped effect; fairly lustrous. Sapwood whitish, with yellow vessel lines; sharply demarcated from heartwood.

Odor and taste not distinctive.

Soft to moderately so, but firm. Sp. gr. (air-dry) 0.50 to 0.60. Weight 31 to 37 lbs. per cu. ft. Grain usually roey, in narrow to wide stripes. Texture medium to coarse. Wood easy to cut, difficult to plane, is fairly durable; green wood saws woolly.

Growth rings: Absent or indistinct; sometimes distance between parenchyma lines is great enough to suggest growth rings.

Parenchyma: In concentric lines, fairly evenly spaced (40 to 60 per inch of radius), fairly regular, sometimes wavy; connecting pores, but not conspicuously about them; distinct on cross section and usually so on longitudinal surfaces where, in proper light, they appear lighter than background and produce wavy patterns on the tangential.

Pores: Rather large; not numerous; well distributed; occurring singly or subdivided into short radial groups; visible without lens; partly open.

Vessel lines: Distinct, but not conspicuous; usually straight on radial surface and in alternating bands of long and short lines.

Vessel contents: Tyloses present, but not abundant.

Rays: Fine, but fairly distinct, on cross section; indistinct on tangential; prominent on radial surface where they appear lighter than background and produce fine silver grain.

Ripple marks: Absent.

Resin and gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; tyloses thin-walled. Rays mostly homogeneous; occasionally with marginal cells square; one to six cells wide and few to 50 cells high; pits in vessels half-bordered, medium sized, often elongated; no latex tubes observed. Wood fibers thin-walled, not arranged in radial rows; pits very small, simple. Parenchyma layers one to six cells wide.

Remarks: Some authors refer to this wood as being of a light red color with white stripes, but this description does not apply to the present material or to the wood of *Moquilea*. The wood closely resembles two Colombian specimens (Yale Nos. 2593 and 2600) labeled "cauchillo" and "caucho," respectively.

Material: Yale Nos. 715, 3204, 3265*, 3499*, 3592, 4231, 4714 (Braz.). Asterisk indicates botanical material.

BROSIMOPSIS

This genus consists of two Brazilian species, namely, *Brosimopsis latescens* Sp. Moore and *B. diandre* Blake.[15] The material of the latter was collected by Mr. H. M. Curran in Bahia, where it is known as "leiteira." According to the collector, this is a fairly common tree in the upper story of the rain forest, where it grows in the same formation as the *Clarisia*, attaining a height of 125 to 150 feet and a diameter of three feet or more, with clear lengths of 50 to 60 feet. The grayish wood shows no contrast between heart and sap portions, is hard, tough, and strong, and used to some extent in the hewn form for heavy con-

[15] Proc. Biol. Soc. Wash., 35: 180, October 17, 1922. Ducke (Arch. Jardim Bot. de Janeiro, 3: 31, 1922) describes a new species, *Brosimopsis oblongifolia* Ducke, which from the description is apparently the same as Blake's. Ducke also considers *Brosimum acutifolium* Huber a species of *Brosimopsis*.

struction which does not come in contact with the ground. Although the felling and hewing of the green timber was accomplished without difficulty, the log supplied by Curran has proved almost impossible to saw when dry, owing to the large amount of gritty substance (silica) in the vessels.

THE WOOD

Brosimopsis diandre Blake *Leiteira.*

Common name: Leiteira (Brazil).

General properties: Color grayish or oatmeal, with a yellowish hue; marked with fine white vessel lines. No distinction between heartwood and sapwood.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.75. Weight about 47 lbs. per cu. ft. Grain straight or fairly so. Texture coarse. Wood full of grit, very difficult to work when dry, splits fairly easily, is tough, strong, splintery, and not durable.

Growth rings: Absent or very poorly defined.

Parenchyma: In narrow circles about the pores and extending from them in fine lines, mostly short, and usually terminating at a ray; sometimes rather long, but always irregular; not distinct without lens.

Pores: Of medium size; some of these very distinct on account of white contents; numerous; well distributed; occurring singly or more often subdivided radially two to several times.

Vessel lines: Appearing as coarse scratches, brownish when empty.

Vessel contents: Gritty white substance, presumably silica, as it dissolves readily in hydrofluoric acid, is present in great abundance, showing clearly on all sections; some tyloses present.

Rays: Very fine; faintly visible on cross and tangential sections; distinct on radial surface, appearing darker than background.

Ripple marks: Absent.

Gum ducts: None observed. Latex tubes present.

Minute anatomy: Pits between vessels minute; tyloses thin-walled, distinctly pitted. Rays heterogeneous; one to five cells wide, few to 60 cells high; laticiferous tubes common; pits into vessels half-bordered, scalariform. Wood fibers rather thick-walled; pits small, simple.

Material: Yale No. 3950 (Braz.) from type tree of the species.

PEREBEA

Nine or ten imperfectly known species of this genus occur in the Amazon Basin, the Guianas, Colombia, and in eastern Panama. *Perebea castilloides* Pittier is a tree 35 to 50 feet high, with the habit of *Castilla*. The latex is yellowish and contains rubber.

Perebea calophylla B. & H. (= *Olmedia calophylla* P. & E.) is said to be one of the tallest trees of the flood plains of the upper and lower Amazon region. It is known as the "caucho-rana" or more often as

"muiratinga" (white wood), a name also applied to *P. Lecointei* Huber as well as to species of *Olmedia* and to other trees with the *Castilla* habit of shedding their slender pseudo-branches or deciduous twigs. According to Correa[16] the wood is said to be used for paper pulp and for charcoal for gunpowder, while the fruits are relished by certain animals, especially tortoises.

The only wood specimen available (Yale No. 4952) was furnished, together with sterile botanical material, by Mr. Gonggrijp, Forester of Surinam, and has been identified provisionally by Dr. S. F. Blake, U. S. Bureau of Plant Industry, as *Perebea* sp.

THE WOOD

Perebea sp. (probably) ***Kapiteinhout.***

Common names: Kapiteinhout, zonderhart (Sur.). Other species: Cauchorana, muiratinga (Braz.); aberemou, vive eperou (Guianas).

General properties: Color grayish-yellow; exposed ends tending to become reddish. No distinction between heartwood and sapwood.

Odor and taste absent or not distinctive.

Moderately hard and heavy. Sp. gr. (air-dry) 0.68. Weight about 43 lbs. per cu. ft. Grain straight. Texture coarse. Wood harsh, easy to split, saws woolly, does not finish smoothly, is not durable.

Growth rings: Poorly defined; sometimes indicated by slight differences in color and also occasionally by parenchyma.

Parenchyma: In wing-like patches about pores, often uniting them into irregular rows; sometimes in concentric lines apparently limiting growth rings; fairly distinct.

Pores: Of medium size; fairly distinct on account of parenchyma; numerous, but not crowded; well distributed; occurring singly or sometimes in small groups; no definite arrangement except where linked together into irregular tangential chains by parenchyma; open.

Vessel lines: Appearing like long deep scratches; not conspicuous.

Vessel contents: None observed.

Rays: Fine, but fairly distinct on cross section; faintly visible on tangential; very distinct on radial, appearing somewhat darker and more lustrous than background; some of them 2 mm. high.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels abundantly pitted, the pits' mouths often coalescing and suggesting spirals. Rays mostly heterogeneous; one to five cells wide, few to over 100 cells high; no laticiferous canals observed; pits into vessels rather large, half-bordered, much elongated, tending to scalariform. Fibers thin-walled; often septate.

Material: Yale No. 4952, from J. W. Gonggrijp of Surinam. (Surinam Herbarium No. 5493). Other species: Yale No. 3501* (Braz.).

[16] Correa, M. Pio: *Flora do Brazil,* Rio de Janeiro, 1909, p. 52.

HELICOSTYLIS

This genus contains four or five species of trees occurring in the Guianas, northern Brazil, and Central America. The Guiana tree is *Helicostylis Poeppigiana* Trec. (= *H. tomentosa* Rusby). Apparently it bears a close resemblance to the letterwood or snakewood, since various specimens of herbarium material submitted by the Conservator of Forests of Surinam and identified by Dr. S. F. Blake as this species, bear the following names: Letterhout (Dutch); letri, sabana letri, man letter, basra letri (Negro-English); moejepau lettoé, poevinga, kapitin hoedoe, pauletoe aledin, basra pauletoe (Saramacca Bush Negroes); warimiaballi, sokoné koereroe, sokoné fieroberoe, perokoti, berekoro, boelikoro (Arowak Indians); paida, toekoesie paida, ombatapo, oenbatapo, ombatappo, tokolo apolikiri, tokoro apolinore (Karaib Indians).

Helicostylis montana Pittier is a large deciduous tree, 80 to 100 feet high and 32 to 40 inches in diameter, with a smooth grayish bark and a globose or elongated crown, growing in the mountains of San Felix Valley, Panama. *H. bolivarensis* Pittier[17] is a Colombian tree. *H. latifolia* Pittier is a laticiferous forest tree of Panama, 65 to 80 feet high and 12 to 16 inches in diameter, with a rough gray bark sometimes nearly one-half inch thick, and having smooth leathery leaves, 1½ to 3½ inches long and one to two inches broad. The wood is little used.

THE WOOD

Helicostylis latifolia Pittier — *Berba.*

Common names: Berba (Pan.). OTHER SPECIES: (See text above).

General properties: Dark reddish-brown. Thick sapwood yellowish. Odor and taste absent or not distinctive.

Hard and heavy. Grain irregular. Texture medium. Wood tough and strong, hard to work, splintery, probably durable.

Growth rings: Fairly distinct, due to slight differences in density.

Parenchyma: In numerous, very narrow, irregular, interrupted, tangential lines; also in narrow layers about pores; faintly visible without lens.

Pores: Small, but visible; numerous; often crowded at beginning of growth rings; occurring singly or more often in radial rows of few to several; mostly closed.

Vessel lines: Rather fine; inconspicuous.

Vessel contents: Tyloses abundant.

Rays: Fine; fairly distinct on cross section; invisible on tangential; distinct, but low and not conspicuous, on radial, appearing of same color as background.

[17] In a letter of Nov. 22, 1921, Mr. Pittier says: "I fear I made a mistake as to the genus when I named my *Helicostylis bolivarensis*. Since the flowers are solitary in the axils of the leaves, it is more likely to be a *Pseudolmedia*."

Ripple marks: Absent.

Gum ducts: None observed; latex tubes present.

Minute anatomy: Vessels with very numerous small bordered pits, screw-head type; tyloses thin-walled, some containing crystals. Rays heterogeneous; one to five cells wide and few to 35 cells high; small laticiferous tubes often present; crystals common; pits in vessels rather large, half-bordered, irregular, often elongated. Fibers very slender, thick-walled, with small simple pits.

Remarks: This wood closely resembles that of *Piratinera panamensis* Pittier, except for the absence of thick-walled tyloses. It does not agree with small branches of *H. Poeppigiana* Trec. from Surinam (Yale Nos. 4943, 4944). In the latter the parenchyma is in more distinct patches about the pores and only occasionally in lines; the rays are considerably coarser and more distinct; and the vessel pits are much larger.

Material: Yale No. 2984, "collected in the dry forest hills around Alhajuela, Chagres Valley, Canal Zone, Panama, male flowers only, May 12, 1911, by H. Pittier (No. 3488)."[18]

CASTILLA (CASTILLOA)

This genus was for a long time considered monotypic, the single species being *Castilla* (*Castilloa*) *elastica* Cerv., the rubber tree of Mexico and Central America. More recently the number of species has been increased to ten, and Pittier[19] says that "he has been able to satisfy himself that most if not all of these forms offer constant characters to be found in all specimens proceeding from a certain area and to be easily recognized by any skilled botanist. At the same time it must be borne in mind that, owing to the uniformity in the general aspect of the representatives of the genus, it really needs an exercised eye to distinguish them on sight."

The range of the genus extends from central Mexico through Central America, into Ecuador, Colombia, Venezuela, and portions of the Amazon region of Brazil. It has been introduced into the West Indies, Ceylon, India, and other tropical countries. "A large amount of capital has been invested in plantations, most of which have failed thus far to justify the oversanguine expectations of the investors" (Pittier, *loc. cit.*, p. 250).

The natural habitat of the trees is in the clearings and other open spots in the virgin forest, where they are generally found in company with *Cecropia*, or in fertile, sparsely wooded alluvial flats. When fully developed, all the species attain large size, in some instances 160 feet in height and over five feet in diameter. The growth is rapid, and in

[18] Cont. U. S. Nat. Herb., 20:3:95 (1918).

[19] Pittier, Henry: A preliminary treatment of the genus *Castilla*. *Cont. U. S. Nat. Herb.*, 13:7:259.

shady places the trunks are slender and support a flat, thinly developed crown; in open, dry places the boles are short and stout and the crowns much larger and heavier. A peculiarity of the tree is the development of long, slender pseudo-branches or deciduous twigs which bear very large showy leaves.[20] The lateral roots spread horizontally and so near the surface that they can often be traced for upwards of 100 feet, and in shady locations may assume a buttress-like shape at their emergence from the trunk. The leaves are deciduous, simple, alternate, large, coarse, and usually densely hairy on both faces. The fruits are rather large, scaly, and pubescent, in some instances containing a soft and sweetish edible pulp.

For a long time *Castilla* was the only source of rubber exported from Mexico and Central America. At least two forms of the tree, *C. fallax* Cook and the "tunu" (species uncertain) of British Honduras, do not produce commercial rubber. The milk of the "tunu" coagulates in a hard, sticky, unelastic mass, erroneously called "gutta-percha" by the natives, the price of which is so low as to render its collection unprofitable (Pittier, *loc. cit.*, p. 265). These trees are sometimes referred to as "hule macho," "caucho macho," or male rubber tree.[21]

It is generally recognized that the castilloa rubber tree of the Amazon Valley is *Castilla Ulei* Warb., known locally as "caucho" in distinction from the Pará rubber, the "seringueira." The caucho is a tree 65 to 125 feet in height and up to six feet in diameter above the buttresses, and covered with a smooth brown bark.

With the exception of the region at the estuaries of the Amazon, east of the Tocontins and north to the Guianas, it occurs throughout the Amazon Basin, especially in the southern tributaries, and on the lower slopes of the Andes in Peru and Ecuador. In some of the lowlands it is associated with Pará rubber. It occurs where the rainfall is between 80 and 160 inches, but with a distinct dry season during which period (August and September) the tree sheds its leaves. The amount of caucho gathered in the Amazon Basin in the commercial year 1910-1911 was estimated to be about 20 per cent of the total rubber produced. The supply came mainly from the upper basins of the rivers Xingue, Tocantins, Tapajos, Purús, Juruá, and Jamary.

The only authentic specimen of the wood of this genus in the Yale collection is that of *C. fallax* Cook (= *Castilloa Tunu* Hemsl.). This is

[20] See Cook, O. F.: The culture of the Central American rubber tree. *Bul.* 49, U. S. Dept. Agr., Washington, D. C., 1903.

[21] Pittier says (*loc. cit.*, p. 266): "The qualificative of 'male,' as used above, is simply the translation of the Spanish 'macho,' which, applied to plants, indicates often, although not always, the absence of certain useful properties found in near related species, rather than any sexual peculiarity."

usually a medium-sized tree, but in the forests of Darien, Panama, it attains a height of 65 feet or more with a diameter of over three feet. The bark yields a soft vegetable cloth used by the Indians for clothing and bedding. The wood is little used, mainly because the abundant latex in the bark makes it unpleasant to handle.

THE WOOD

Castilla fallax Cook — *Tunu.*

Common names: Tunu, toonu, caucho macho, cauchillo, hule macho, chaperno,[22] gutta-percha, male rubber tree, sterile rubber tree (C. A.). OTHER SPECIES: Central American rubber tree, Mexican rubber tree, Panama rubber tree (Eng.); hule, ule, ule-ule, tunu, toonu (C. A.); caucho, arbol de ule (Mex.); caucho centro-americano (Venez.); caucho (Braz.).

General properties: Color light brown; sapwood nearly white; not sharply defined.

Odor and taste absent or not distinctive.

Light and soft, though firm. Grain fairly straight. Texture rather coarse. Easy to cut, saws rather woolly, is rather tough and strong for its weight; is not durable.

Growth rings: Poorly defined; sometimes indicated by more abundant parenchyma.

Parenchyma: About pores and sometimes connecting them tangentially; also in occasional concentric bands; readily visible.

Pores: Medium-sized; distinct on account of parenchyma about them; fairly numerous, but not crowded; occurring singly or occasionally subdivided radially; closed.

Vessel lines: Distinct, due to parenchyma.

Vessel contents: Tyloses abundant.

Rays: Very fine; faintly visible on cross and tangential sections, fairly distinct on radial surface, appearing somewhat darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessel perforations simple; tyloses thin-walled. Rays often somewhat heterogeneous; one to four cells wide, few to 50 cells high; many cells gummy; no laticiferous tubes observed; pits into vessels rather large, often elongated, simple to half-bordered. Fibers thin-walled; often septate. Pith large. Inner bark fibrous.

Material: Yale No. 2987, collected by Dr. Pittier in Panama; his No. 5696.

OLMEDIA

This genus, consisting of ten or eleven species, extends on both sides of the continental divide from Peru northward to Costa Rica, and east-

[22] "'Chaperno' is a Spanish name, generally applied to certain hard-wood leguminous trees" (Pittier, *loc. cit.*, p. 266).

ward to the Guianas and Brazil. *Olmedia caucana* Pittier, of Colombia and Panama, is a small tree, 15 to 20 feet high, with erect-ascending limbs, and with rather large leaves suggesting those of chestnut (*Castanea*), though not so prominently toothed.

Huber[23] says that some of the species of *Olmedia* are large trees in the Amazon region. The wood of the "muiratinga," *O. caloneura* Huber and *O. obliqua* Huber, does not have any economic application. To another species of the same genus Huber gives the name *O. erythrorhiza* on account of its intensely reddish roots which, like those of the "caucho" (*Castilla*), are visible for long distances from the trunk. This tree is scattered in the high flood plains of almost all of the Amazon region, being well known under the name of "guaribu" in Brazil and "maxunasti" in eastern Peru, and furnishes large logs of beautiful fine-textured and figured wood employed in civil and naval construction, and suitable for cabinetwork. According to Correa,[24] the wood of the "muiratinga verdadeira," *O. caloneura* Huber, finds its principal use in the making of wooden bowls, spoons, and other domestic utensils, though suitable for paper pulp and for charcoal for gunpowder. The bark contains a viscous latex.

PIRATINERA[25]

This genus is noted for being the source of letterwood or snakewood which has been an article of export from the Guianas since their earliest settlement. As evidence of the early importance of the industry it is interesting to note that article 7 of the capitulation of March 6, 1667, by which the British Lieutenant General William Byam gave over the Colony of Surinam to the Dutch Admiral Abraham Orijnssen, specified that the first English settlers would have the free right to cut letterwood

[23] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:171 (1909).

[24] Correa, M. Pio: *Flora do Brazil*, Rio de Janeiro, 1909, p. 53.

[25] The name *Piratinera* Aubl. (1775) has usually been referred to *Brosimum* Swartz (1788), and the latter name was made *nomen conservandum* by the International Botanical Congress at Vienna in 1905. In 1918, however, Pittier (Cont. U. S. Nat. Herb., 20:3:96-105, 1918) submitted evidence to prove that *Piratinera* and *Brosimum* are in reality distinct and well-founded genera. More recent studies by Dr. S. F. Blake, of the U. S. Bureau of Plant Industry, have tended to justify this separation. Pittier listed five species, namely, *Piratinera guianensis* Aubl., *P. discolor* Pittier (= *Brosimum discolor* Schott), *P. rubescens* Pittier (= *B. rubescens* Taub.), *P. acutifolia* Pittier (= *B. acutifolium* Huber), and *P. panamensis* Pittier. Blake (Journ. Wash. Acad. Sci., 12:7:391-399, Oct. 19, 1922) established two new species, namely, *P. scabridula* Blake and *P. velutina* Blake, and has referred *P. discolor* (Schott) Pittier to the synonymy of *P. guianensis* Aubl. See also Arch. Jardim Bot. de Rio de Janeiro, 3:23-30, for descriptions of *Brosimum* and *Piratinera* by Adolpho Ducke.

on the river.[26] It is said that much of the early supply came from old down timber, the so-called "tabukas," from which the sap had rotted away.

Although the name snakewood is applied to a number of woods, the one of most importance and by far the best known is that from Surinam, the heartwood of which resembles the skin of some of the highly colored snakes. The trade name leopard wood has also been given to it because of its irregular, dark-colored spots so conspicuous on a brightly polished surface. In French Guiana it is called "bois de lettres," in reference to the fancied resemblance of these irregular markings to the letters of the alphabet. From this name the English coined the word letterwood and the Dutch, "letterhout."

The letterwood tree often attains a height of from 75 to 85 feet, with a diameter of two to three feet near the base, and has a slender clear bole, with a smooth bark containing a thin, sticky, white latex. The leaves are small, simple, and entire. The tree occurs in moist forests from Panama southward through Colombia to Peru and eastward to the Guianas and Brazil. On the San Blas coast of Panama it is said to be moderately abundant, but in the Guianas and in parts of Venezuela it is now very rare. There is little information available about its occurrence in Brazil, though the wood is brought down the Amazon.

Only the heartwood is valuable and this is often very small. The trees vary in this regard and in Surinam certain creeks have a reputation among the letterwood hunters for producing timber with a thick core of heartwood, while on other creeks trees two to three feet in diameter may be almost all sapwood. Measurements, inside the bark, of sections of eight tree trunks in the Yale collection from Surinam give the following results (in inches):

	1	2	3	4	5	6	7	8
Ave. total diam.:	6.75	8.0	10.0	11.0	12.0	12.5	13.0	15.0
Ave. diam. heartwood:	0.75	1.0	2.5	0.75	1.5	1.5	3.5	1.0

The peculiar markings which give the wood its name and its value extend radially through the stem and vary greatly in size and number. In tracing them radially it is found that they are much branched and anastomosed so that the figure on the tangential surface is never the same at different depths. The microscope fails to reveal any difference in the structure of the light and dark areas, though there are very noticeable variations in the color of the gum which fills all the cell cavities, the darkest portions being at the margins rather than in the

[26] "Dat se sullen hebben privilegie om letterhoudt te kappen in de rivier."

center of the patches. The darkening of the cell contents is presumably due to oxidation, but no satisfactory explanation can be given as to the radial localization. There is no noticeable difference in the size, number, structure, or contents of the rays, or the distribution of the radial latex tubes, nor is there any indication of fungous or other injury, though wounds in the sapwood may induce the formation of islands of colored heartwood, as is the case in many other trees.

These hieroglyphic markings occur in woods of all species of *Piratinera* so far as known, but they are not a constant character. From the evidence available it appears that in some of the trees without distinction as to species the heart is marked only with vertical black stripes, such as may occur also in the speckled wood. A specimen of beautifully figured snakewood veneer in the Yale collection shows a longitudinal black stripe about a quarter of an inch wide along each edge, while the narrow portion outside is almost plain. The negroes who make a business of cutting letterwood cannot tell whether or not a tree has speckled heartwood until they cut through the sapwood. Trees with plain wood are considered false or bastard kinds, but our present knowledge indicates that these differences are individual rather than specific or even varietal, and that the speckled wood is in somewhat the same category as "bird's-eye" maple.

Letterwood enters the market in the form of small logs or sticks about seven feet long and from two to eight inches in diameter, with all sapwood removed. It is sold by weight and is one of the most expensive woods in the trade. It is very strong, though brittle, and was formerly used by the South American Indians for bows. Its principal use now is for walking sticks, for which purpose it is considered one of the finest of all woods, though it is difficult to bend without buckling and is also likely to split. Other uses are umbrella handles, drum sticks, fishing rod butts, and miscellaneous fancy articles. It is occasionally employed in violin bows, but is not very highly esteemed for this purpose. The larger sticks are sometimes sawed into thin veneers for cabinetwork. Owing to the difficulty of finding a specimen of much size that is finely figured throughout, it is a common practice to stain patches of plain wood to simulate the natural markings.

The sapwood, comprising by far the greater bulk of the tree, is left in the forest. It is hard, tough, and strong, and has been suggested as a possible substitute for boxwood, though unsuited for that purpose because it is not of sufficiently fine texture and the grain pulls out badly in working. It would possibly make good handles for implements and tools. The following table shows the density of various specimens of sapwood and, in two cases, the relative density of heartwood and sap-

wood from the same cross sections of the trunks. In two instances the sapwood from the same section was divided and the results show inconsistent variations. The woods were all thoroughly air-dry when tested.

Density of Sapwood and Heartwood of Piratinera

Yale No.	*Kind of wood*	*Sp. gr.*	*Yale No.*	*Kind of wood*	*Sp. gr.*
4947	Sapwood	0.977	4951	Heartwood	1.243
4948	Sapwood, inner half	0.955	4953	Sapwood, inner half	1.103
4948	Sapwood, outer half	1.015	4953	Sapwood, outer half	0.991
4950	Sapwood	0.958	4953	Heartwood	1.348
4951	Sapwood	1.026			

THE WOOD

Piratinera guianensis Aubl. (and other species) *Letterwood; Snakewood.*

Common names: Letterwood, snakewood, leopard wood, speckled wood, tortoise-shell wood (Eng.); bois de lettres, bois de lettres de Chine, bois de lettre moucheté, bois d'amourette moucheté (Fr.); letterholz, buchstabenholz, schlangenholz, muskatholz, tigerholz (Germ.); letterhout, letterhoudt (Dutch); legno tigre, legno serpente (Ital.); burokoro, burracura, bourracourra, boutous, cangica, paira, tibikushi, tibicusi (B. G.); letterhout, man letterhout, roode letterhout, gespikkeld letterhout, letri, manletri, kapeweri letri, basra letri, poevinga, paulétoe, bepaulétoe, moejepauletoe, kolero, koelero, koereroe, belekoro, boelekolle, sokoné biberoe, paida, wekere paida, tianalin wéwé, tokoro apolli merie (Sur.); bois de lettre moucheté, bois de lettre gris, piratiner, piratininere (Fr. G.); bois lezard (Leeward Is.); muirapinima, muirapenima, moira pinima, mururé, gatia, gateado, gamelleira preta, páo rainha de listras, páo tartarugo, páo vermelho, barrueh, oiti-mirim-ayra (Braz.); guaímaro, casique care (Pan.); lignum literatum.

General properties: Dark red or reddish-brown, with peculiar dark letter-like markings suggesting a snake skin; sometimes with vertical black stripes only, or in conjunction with speckles. Sapwood very thick, white or yellowish; line of demarcation often irregular and not very sharp.

Odor and taste absent or not distinctive.

Extremely dense and compact; horn-like. Sp. gr. (oven-dry) 1.20 to 1.36. (See table.) Weight 75 to 84 lbs. per cu. ft. Grain usually very straight. Texture fine. Wood hard to cut, splits readily, takes a high polish, is very strong, but brittle; heartwood very durable, sapwood perishable.

Growth rings: Absent.

Parenchyma: Inconspicuous; in narrow wings from pores and sometimes confluent into short to fairly long narrow lines.

Pores: Very small, but visible; only fairly numerous; well distributed; mostly solitary, but sometimes in small groups; closed.

Vessel lines: Long, fine, straight, inconspicuous.

Vessel contents: Vessels filled with dense thick-walled tyloses.

Rays: Very fine; faintly visible on cross section; invisible on tangential; distinct, but not conspicuous, on radial where they appear somewhat lighter than the background.

Ripple marks: Absent.

Minute anatomy: Vessels with very small bordered pits; abundant tyloses with very thick laminated and pitted walls, resembling stone cells, having very small cavities sometimes containing red gum or crystals of calcium oxalate; thickening process begins in sapwood, sometimes within one inch of bark, those beyond being thin-walled. Rays mostly one to three cells wide and few to 20 cells high; gummy; marginal cells (one to several rows) square or upright, with thick sclerosed walls and containing crystals of calcium oxalate, often two per cell; sclerosed cells sometimes interspersed; small latex-tubes often present; pits into vessels small, half-bordered, elongated in part. Wood parenchyma very thick-walled, abundantly pitted, gummy, often containing crystals. Fibers slender, very thick-walled, arranged in radial rows; pits very small, indistinct, simple; cavities filled with gum.

Remarks: A specimen (Yale No. 3572) of a fallen tree collected by Mr. Curran in Colonia, Rio Gongogy, Bahia, Brazil, is undoubtedly a species of *Piratinera;* the native name given is "amora branca." Another specimen (Yale No. 3495), from Pedras Pretas, Bahia, collected under the name of "aimpem," is also referable to this genus.

Material: Yale Nos. 4946, 4959*, 4960*, 4961*, 4962, 4963 (B. G.); 4186, 4942*, 4945, 4946, 4947, 4948, 4950, 4951, 4953 (Sur.); 2985* (Pan.); 1438, 1439, 4024 (Braz.). Asterisk indicates botanical material.

BROSIMUM[27]

The most noted tree of this genus is the cow tree, *Brosimum utile* Pittier (= *Galactodendron utile* H. B. K. = *Brosimum Galactodendron* D. Don). It occurs in South and Central America, from Venezuela to Guatemala and probably into southern Mexico, and attains a height of 65 to 80 feet and a diameter of 16 to 20 inches. The leaves are large and leathery; the bark is rich in latex having many of the properties of milk, thus giving rise to the name cow tree, "palo de vaca," or "palo

[27] Pittier (*loc. cit.*, p. 101) considered the following nine species as definitely included in this genus after separating it from *Piratinera: Brosimum alicastrum* Swartz (W. I. and Mex.); *B. costaricanum* Liebm. (C. R.); *B. utile* (H. B. K.) Pittier (tropical America); *B. Gaudichaudii* Trecul (W. Braz.); *B. glaucum* Taub. (Braz.); *B. Glaziovii* Taub. (Braz.); *B. guianense* Huber (Amazon); *B. pusillum* Hassler (Paraguay); and *B. terrabanum* (Cent. Am.). Four species are discarded or considered doubtful. Blake (Proc. Biol. Soc. Wash., 35:179, Oct. 17, 1922) has recently described a new species, *B. columbianum* Blake, from material collected by Mr. Curran in Colombia. In another paper (Journ. Wash. Acad. Sci., 12:7:391-399, Oct. 19, 1922) he shows that the name *Brosimum guianense* Huber is technically based on *Piratinera guianensis* Aubl. and, therefore, falls into synonymy when the two genera are separated. *Brosimum Aubletii* P. & E., the name commonly applied to the letterwood of Guiana, is a synonym of *Piratinera guianensis* Aubl.

de leche." The tree was first brought to the attention of botanists by Humboldt,[28] who found it in the coast cordillera of Venezuela.

Pittier says (*loc. cit.*, pp. 103-104):

Humboldt and Bondpland were inclined to think that this tree was peculiar to the coast cordillera of Venezuela, whereas subsequent information shows that its area is a very extensive one. With reference to Central America, I observed it in 1891 on the hills bordering the San Juan River on the Costa Rican side. On January 22, 1898, I camped on the ridge dividing the Savegre and Guavo rivers in Costa Rica, at the foot of a gigantic tree called "mastate" by my Brunka guides. When incised the bark yielded an abundant milk, of which I drank a whole cup without suffering any inconvenience. The bark was formerly used as a clothing material by the Indians. At the time when this tree so came under my notice, botany was only a secondary interest to me, and I did not try to collect specimens or to identify the species, but there are strong reasons for believing that it was the "palo de vaca" of Humboldt, the area of which is thus extended west and northward to the borders of Nicaragua. Around Puerto Obaldía it is a common element of the forest, called "palo de leche" by the natives, but it was not found in the course of my exploration in any other part of the Republic of Panama.

To the names "cow tree" and "palo de vaca," those of "árbol de leche," "palo de leche" and "avichurí," used in Colombia, may be added, the last evidently indigenous. Cortes[29] reproduces the following analysis by Heintz, showing that the milk is not such a substantial food as had been affirmed by Humboldt:

Water	57.3
Albumin	0.4
Wax of the form C_{35} H_{66} O_3	31.4
Wax of the form C_{35} H_{58} O_7	5.8
Gum and sugar	4.7
Salts	0.4

Brosimum alicastrum Swartz is the breadnut of Jamaica, where the seeds roasted singly or boiled together and reduced to a paste, are used as food, having a taste not unlike that of a hazelnut. The same species is reported from Yucatán under the Maya name of "ox" (Seler) of "oox" (Schott) and the Spanish names of "ramón" and "hoja ramón." The leaves and young shoots are there considered an excellent cattle feed, but no mention is made of the fruits. In Jamaica the name "ramón," or "ramoon," is applied to *Trophis americana* L., another tree of the mulberry family from which green fodder is obtained. According to Liebmann and others, this species extends into Central Mexico as far as Colipa and Papantla, where cattle also feed on the leaves, the vernacular name being "ojite."

[28] Humboldt, Alexander von: *Personal narrative of travels to the equinoctial regions of America, during the years 1799-1804*, Eng. ed., London, 1852, vol. II, pp. 47-48.

[29] Cortes, Santiago: *Flora de Colombia*, Bogata, 1897, p. 126.

The fruits of *Brosimum costaricanum* Liebm., are used to a small extent in the same way as the breadnut of Jamaica, and the flowers, which cover the ground under the trees at the time of blooming, are said to enter into the preparation of a savory pie. Both this species and *B. terrebanum* Pittier afford fodder and are known under the common name of "ojoche." As in the Mexican "ojite," the primitive Maya root "ox" is here readily recognized, as it is also in "ojuste," the Honduran vernacular for another unidentified species. But the ending "joche" or "juche" (found besides in "cacalojoche," "esquijoche," "quisjoche," etc.), is derived from the Nahuatl "xochitl," flower, and hence it is also supposed the original meaning of "ojoche" may have been *o-jochitl,* flower of the trail, on account of the deciduous receptacles covering the forest paths at a certain period of the year.

Whitford and Stadtmiller collected *B. terrebanum* along the Guatemala-Honduras boundary under the name of "maseco." A Mexican species is called "capomo" or "nazareno."

The "mureré" of the Amazon is, according to Huber (*loc. cit.*, p. 170), a species of *Brosimum* closely related to *B. acutifolium* Huber.[30] The milky latex is recommended in popular medicine as an effective remedy for leprosy. Huber states that a specimen of this wood received from the Augusto Montenegro experiment station, under the name of "mureré vermelho," is lighter in weight than the "muirapinima" (letterwood) and the "muirapiranga," and the heart is of a beautiful yellow color, while the sapwood shows alternate zones of white and red.

The "guayamero" of Colombia, *B. columbianum* Blake, is a recently described species, collected by Mr. Curran, who says that it grows scatteringly in the lowland forests of the Magdalena River, where it attains a height of 100 feet, has a cylindrical bole with clear lengths of 40 to 50 feet and diameters up to three feet. The bark is thin, and smooth, superficially, resembling beech (*Fagus*), and has little or no latex. The wood is light-colored, hard, heavy, and strong, and though not used locally, presumably on account of its lack of durability, may prove of merit as a substitute for hickory (*Carya*). This wood is taken as the type of the foregoing group.

THE WOOD

Brosimum columbianum Blake — *Guayamero.*

Common names: Guayamero, guaimaro (Col.). Other species: (See text above.)

General properties: Color grayish-yellow or nearly white. No distinction between heart and sapwood.

Odor and taste absent or not distinctive.

[30] = *Brosimopsis acutifolia* (Huber) Ducke, Arch. Jardin Bot., Rio de J., 3:30 (1922).

Hard and heavy, suggesting hickory (*Carya*). Sp. gr. (air-dry) 0.81. Weight about 51 lbs. per cu. ft. Grain mostly straight. Texture medium. Rather easy to work, takes a smooth finish, is inclined to be splintery, does not warp or check badly, is very strong; not durable.

Growth rings: Absent or poorly defined; sometimes indicated by fairly regular zones deficient in pores and parenchyma.

Parenchyma: In narrow, faintly visible, wavy, tangential lines connecting pores; short to long; sometimes fairly regular and concentric.

Pores: Small; not distinct without lens; fairly numerous, but not crowded; well distributed; occurring singly or occasionally sub-divided radially two to several times; open.

Vessel lines: Fine and distinct; appearing darker than background, due to parenchyma sheaths.

Vessel contents: None observed.

Rays: Fine; faintly visible to fairly distinct on cross section; invisible on tangential; distinct, but low and inconspicuous, on radial surface, appearing somewhat darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with small bordered pits; tyloses apparently absent. Rays decidedly heterogeneous; one to five cells wide and few to 30 cells high; crystals of calcium oxalate abundant; no latex tubes found; pits into vessels small, half-bordered to simple, often elongated. Wood fibers moderately thick-walled, with small simple pits.

Remarks: Brosimum terrabanum Pittier (Yale No. 3675) has the same general appearance, but is not quite as dense, has somewhat larger pores, the parenchyma is sparingly developed, and there are occasional latex tubes in the rays. There is no contrast between heart and sapwood.[31]

Material: Yale No. 1531 from type tree 100 feet high and 25 inches in diameter collected by Curran in 1916 in the vicinity of Estrella, Dept. of Bolivar, Colombia; his No. 304.

DOUBTFUL SPECIES HAVING RED WOOD

The woods of the foregoing species, the only ones of the genus that are well established, are apparently all light-colored throughout. The "muirapiranga"[32] of the Amazon region, *Brosimum paraense* Huber, is distinguished from the others by having a large core of beautiful red heartwood as well as by its oval or elliptical and entirely smooth leaves and its slender and pointed buds. Huber (*loc. cit.*, pp. 169-170) calls attention to the similarity of this tree to the "condurú de sangue" of the Tocantins, to the "palo de sangre" of the Peruvian Amazon, and also

[31] Dr. Pittier says in a letter of November 22, 1921: "As far as I can remember, the wood of the Central American species of *Brosimum* is rather light-colored,—white wood, as usually termed."

[32] This name means "red wood" and its application is not limited to this species.

to the "bois de féroles" or "satiné" of French Guiana, *Ferolia guianensis* Aubl. (Rosaceae).

Attempts by the authors to solve this problem have so far been only partially successful. Mr. Gonggrijp, Forester of Surinam, kindly forwarded sterile botanical material and a section of the trunk of the "satiné rubanné" collected by Forest Ranger L. Junker on Mawassie Creek, Surinam River, where it occurs scattered through the tropical rain forest. It is a large tree with a cylindrical bole two to three feet in diameter, with a thin, smoothish, latescent bark marked with long, narrow, horizontal ridges which give it a finely wrinkled appearance. The Negro-English name for it is "ajeersi," which means that the tree resembles the letterwood. The Arowak Indians call it "oolemeriballi," "warimiballi," and "sokonéballi,"[33] and the Caraib name is "adda."

The herbarium material, referred to above, agrees with the specimens of *Brosimum paraense* Huber in the U. S. National Herbarium at Washington. In a letter of January 23, 1922, Dr. S. F. Blake, Assistant Botanist, Bureau of Plant Industry, wrote as follows: "*Brosimum paraense* Huber is represented in our herbarium by supposedly authentic (but not type) material as follows: Ducke 16991, with very young heads, and No. 8149, leaves only, which from the data evidently belongs to the specimens collected by Marinho, and referred by Huber in his original description to this species. Although the flowering material is too young to show the character of the flowers, I have very little doubt that it represents a species of *Piratinera*. . . . Nevertheless, in view of the unsatisfactory character of the material at present available, I do not feel justified in making the generic transfer." Pittier, after a study of the same material, listed *B. paraense* Huber under the heading "Doubtful and discarded species of *Brosimum*," though he states (*loc. cit.*, p. 104) that it "is probably a good species, but the description of the inflorescence is incomplete." The structure of the wood indicates a closer affinity to the letterwood than to any other known kinds in this family, but is conspicuously different in the relative thickness and sharpness of demarcation of heart and sap as well as in the markings of the wood.

The Yale collections include three wood specimens of "satiné" from French Guiana and Surinam, seven of "muirapiranga" of the middle Amazon, three of "palo de sangre" of the upper Amazon, one of "condurú" from a commercial source in Bahia, Brazil, and one of "cacique" from the north coast of Panama. Only one (Yale No. 4782, from Surinam) is accompanied by herbarium material (see above), though Yale

[33] The suffix "balli" means "like" or "resembling." Thus "sokonéballi" means that the tree resembles "sokoné," one of the names given to *Helicostylis* sp.

No. 4006 is from one of Dr. Huber's collections. A careful study of these shows a very great similarity in their structure, though the "condurú" is less dense and considerably coarser-textured than the others. According to the Rebouças,[34] "condurú" or "gondurú" is *Brosimum Conduru* Fr. Allemão. The tree is found in the provinces of Pará, Maranhão, and Bahia, and has a trunk 12 to 16 inches in diameter and 25 to 30 feet tall. The wood has a specific gravity of 0.885; and is used in civil construction and in joinery. The color is said to be a beautiful deep yellow. The specimen in the Yale collections (No. 3527) is red instead of yellow, but it has a beautiful luster and may have been of much lighter color when first cut. A commercial specimen of "satiné" (Yale No. 4437) exhibits a beautiful blending of wine-red and golden yellow striping.

The woods of this group are among the finest of the cabinet woods. An old specimen of "palo de sangre" (Yale No. 1426) was inscribed by the collector as "the very best timber in Amazonas." A small shipment of round logs of "palo de sangre," four to six feet long and 20 to 30 inches in diameter, was received in New York in December, 1922. Some of the early period furniture of the French contains veneers of "satiné," and it is now very rare. Boulger[35] describes it as "red, splashed with yellow, hard, solid, and of good quality, tough, elastic, working well, and susceptible of a beautiful polish. Used for furniture and cabinetwork, bows, and fishing rods. The Arowak Indians use this wood for making their bows, the same as the letterwood."

There are two different woods in French Guiana known as "satiné"; that belonging to the Moraceae is usually called "satiné rubanné"; the other, "satiné rouge" (Yale No. 5348; Musée Colonial de Marseille No. 109), has ripple marks and appears to belong to the Leguminosae. Most writers consider it a species of *Ferolia* or *Parinarium* (Rosaceae), others as *Amanoa* sp. (Euphorbiaceae), and it has also been confused with "washiba," *Tecoma* sp. (Bignoniaceae).[36]

THE WOOD

Brosimum paraense Huber — *Satiné.*

Common names: Satiné, satiné rubanné, satiné rubané, satiné gris, bois de féroles, bois de lettre rouge, bois de Cayenne, bois baroit, bois marbre ? (Fr. G.); satiné rubanné, ajeersi, oolemeriballi, warimiballi, sokonéballi, addà (Sur.); muirapiranga, meurapiranga, moira-piranga, condurú, condurú

[34] Rebouças, André e José: *Ensaio de indice geral das madeiras do Brazil,* Rio de Janeiro, 1877, vol. I, p. 389.

[35] Boulger, G. S.: *Wood,* London, 1908, p. 270.

[36] See Stone, Herbert: Les bois utiles de la Guyane française, *Ann. Mus. Col. de Marseilles,* 5:3:145 (1917).

de sangue, cundurú, gondurú (Braz.); palo de sangre (Peru); cacique (Pan.); Brazil redwood, cardinal wood (Misc.).

General properties: Color lustrous red with golden sheen; uniform to variegated, sometimes with blended stripes of yellow and red; looks waxy. Sapwood gray or oatmeal-colored, about 1.5 inches thick, very sharply and regularly defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (oven-dry) heartwood 0.95; sapwood, 0.71; air-dry heartwood usually heavier than water. Weight (air-dry) 60 to 63 lbs. per cu. ft. Grain usually very straight. Texture fine. Wood fairly easy to work, takes a high polish, splits easily into long thin slivers and is likely to pull out under tools, is highly durable.

Growth rings: Absent or obscure.

Parenchyma: Visible, but not conspicuous; in narrow wings from pores or pore-groups, often confluent into irregular lines.

Pores: Small or rather small; readily visible; not very numerous; well distributed; solitary or less often in small groups; closed in heartwood.

Vessel lines: Long and straight; distinct; somewhat darker than background.

Vessel contents: Tyloses present and often abundant.

Rays: Fine, but distinct, on cross section; faintly visible on tangential; fine, but very distinct, on radial, where they are darker than background.

Ripple marks: Absent.

Gum ducts: None observed. Latex tubes present in rays; usually visible under lens in sapwood.

Minute anatomy: Tyloses mostly thin-walled; some sclerosed, laminated, abundantly pitted. Rays heterogeneous, some moderately, some decidedly so; all cells usually have walls of same thickness, sometimes sclerosed cells occur; one to three (rarely four) cells wide, few to many cells high, the largest rays being 0.50 to 1.12 mm. high and 0.03 to 0.04 mm. broad, rarely more; cells filled with gum; pits into vessels half-bordered to nearly simple, often elongated. Latex tubes present; in some instances two or three in one ray; mostly small, 0.017 to 0.02 mm. (in one specimen 0.057); mostly with clear yellow, rarely dark, contents. Fibers slender, with thick walls and small cavities usually filled with gum; pits numerous, small, but distinct, on radial wall, slit-like with small circular borders.

Remarks: The "satiné" with yellow streaks resembles the Brazilian tulip wood (Leguminosae) but the colors blend together and are not so sharply defined as in the tulip wood; moreover the latter has ripple marks.

Although the "satiné" woods are much alike, they exhibit enough variation in structure to lead to the conclusion that there are two or three species represented in the list below.

Material: Yale Nos. 4782* (Sur.); 4437, 5346, 5883 (Fr. G.); 1426, 3527, 4006, 5349, 5350, 5912, 5943, 6042 (Braz.); 1426, 1817, 6942 (Peru); 6747 (Pan.); 6893 (Venez.). Asterisk indicates botanical material.

FICUS

This genus consists of over 600 species of trees or shrubs widely distributed throughout the warmer regions of the whole world, being most abundant in the East Indies and Africa. The most commonly known representatives are the common cultivated fig, *Ficus Carica* L., and the rubber plant of the florists, *F. elastica* Roxb., a native of Asia and Malaysia. The latter species is a gigantic evergreen tree in India and its latex supplies the india rubber of commerce. The famous "banyan," *F. bengalensis* L., sends aerial roots from the branches to the ground and these grow into separate trunks, but with a single crown which may have a lateral spread of over 300 feet. The "peepul" or "pipal" tree, *F. religiosa* L., another well-known East Indian tree, is commonly planted in villages and held sacred both by Hindus and Buddhists. The sycamore used by the Egyptians for mummy cases was *Ficus Sycomorus* L.

There are over 30 species of *Ficus* in the West Indies, about 50 in South America, and about 40 in Mexico and Central America. Standley[37] says: "It is a remarkable fact that only two of these are common to the West Indies and Central America, and one of them is doubtfully indigenous to the latter region."

There are three general types of *Ficus* plants, namely, (1) the lianas, very common in the forests and ranging in size from very small up to about eight inches in diameter; (2) the strangler figs, which usually start as epiphytes and as they develop throw down aerial roots which enwrap the host tree and finally kill it; (3) the forest trees, which grow normally, sometimes to a height of 150 feet, with diameters of four or five feet, and lengths upward of 60 or 70 feet. The strangler figs, known in Brazil as "mata-páos" (tree-killers) or "cipo mata-páos" and in Central America as "mato palos," may eventually assume the appearance of normal trees, but in many instances they present a lattice-like appearance, the inside hollow after the host tree has rotted away. The bark is smooth and full of latex.

The woods of *Ficus* are of fairly uniform structure, being composed of alternate bands of hard and soft tissue, their comparative thicknesses varying in different species. This laminated structure is distinct on all sections, particularly so when the soft layers have turned dark brown, as is so frequently the case. They are usually light and soft, though exhibiting considerable range in this respect, but are tough and strong for their weight. The fresh wood is white or gray, but stains very readily. The pores are usually few, large and distinct, mostly subdivided, and

[37] Standley, Paul C.: The Mexican and Central American species of *Ficus*, *Cont. U. S. Nat. Herb.*, 20: 1: 1 (1917).

scattered irregularly. The rays are mostly fine, though visible, irregular, and heterogeneous. Ripple marks have been noted in *F. altissima* Blume of India (Yale No. 3818) and *F. Benjamina* L. of the Philippines (Yale No. 2394), all elements being storied with about 65 marks per inch. Gum ducts and latex tubes have not been observed.

At present the trees of this genus are considered as weeds of the forest, since their wood is very sappy and likely to rot before it can be dried. In regions where timber is scarce it is sometimes used for making boxes and for very light construction. If the lumber were kiln-dried before it had a chance to decay it would make excellent box shooks, as it is light-colored, easy to work, and will hold nails firmly. The trunks of large trees are sometimes used for making dugout canoes. In preconquest times, the Aztecs of Mexico made extensive use of the bark of fig trees for the preparation of paper for their records and correspondence.

Common names: Fig, fig-tree, wild fig (Eng.); jagüey, jiguerillo, hagüey, higuero, higuillo preto, lechesillo (P. R.); jagüey, jagüey hembra, jagüey macho, alamo (Cuba); figuer, gros figuer, figuer petites feuilles (Fr. W. I.); dukalaballi (B. G.); doekoelia, doukaliebalie (Sur.); fig tree, figuer, pan del año, Scotch attorney, matapal, lechero, atagua (Trin.); caucho, cerote, higuerón (Col.); amate, amate amarillo, amate blanco, amate prieto, amatillo, amatito de montana, alamo, camichín, comuchín, coobo, kopó, capulín grande, higuera, hule, nacapuli, ojite, palo de coco, texcalama (Mex.); amato de hijo grande (Salv.); mato palo, capulín amate (Guat.); chilamate, higuerón, higuerón colorado, palo de agua (C. R.); mata-páo, cipo mata-páo, gamelleira, gamelleira branca, gamelleira de lombrigueira (Braz.); higuera, higuerón, lecheleche, matapalo, renaco (Peru); higuera, higuera blanca, higuera del agua, higuera del Chaco, higuera morada, ibapoí, ibapoí-morotí, ibapoý-say (Arg.).

Material: Yale Nos. 387 (Col.); 1019 (Arg.); 1939* (Braz.); 2394, 2395, 2396, 2397, 2398, 2399 (Phil. Is.).

COUSSAPOA

This genus consists of about 30 species of trees, shrubs, and woody lianas occurring in southern Mexico, Central America, Peru, and Brazil. They are stone-fruited, have a milky latex, and the leaves are large, leathery, and undivided. *Coussapoa Curranii* Blake is a woody liana about 65 feet high, discovered by Mr. Curran in the State of Bahia, Brazil. The local names are "cibuero" or "gummilera" ("gamelleira" ?). *C. Rekoi* Standley is a Mexican species known in Oaxaca as "carnero" and "chirimoya." It is distinguished from all other species of the genus by the prickles of the branchlets, stipules, and leaves. The fruit is said to be edible and the leaves are sometimes 20 inches long.

The only authentic wood specimen in the Yale collections is of *C. Ruizii* Klotzsch, collected with fertile botanical material along the Guatemala-Honduras boundary line by Whitford and Stadtmiller. It is from a small latescent tree about 30 feet high and seven inches in diameter.

THE WOOD

Coussapoa Ruizii Klotszch — *Chirimoya* (?).

Common names: Chirimoya ? (C. A.). Other species: Chirimoya, carnero (Mex.); cibuero, gummilera (Braz.).

General properties: Color pinkish-grayish or oatmeal, becoming somewhat yellowish upon exposure. Sapwood not distinguishable from heart.

Odor and taste absent or not distinctive.

Of medium density and hardness. Grain straight to somewhat irregular. Texture rather coarse. Wood fairly easy to work, finishes smoothly, is not durable.

Growth rings: Indistinct; limited by concentric parenchyma lines more regular than the others.

Parenchyma: In numerous tangential or concentric lines or bands, mostly very irregular and of varying widths, often connecting pores; also in narrow layer about pores; readily visible on all sections, but not conspicuous.

Pores: Variable in size from medium to large; distinct; rather few; irregularly scattered; occurring singly or subdivided radially two or more times; mostly closed in heartwood.

Vessel lines: Appearing as distinct coarse scratches, darker than background.

Vessel contents: Tyloses abundant in heartwood; white substance occasionally present.

Rays: Fine; faintly visible on cross and tangential sections; distinct, but low and fine, on radial surface, appearing darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Rays heterogeneous; gummy; one to six cells wide, few to 35 cells high; most of the cells very small; no laticiferous canals observed; pits into vessels large, irregular, half-bordered. Wood fibers with numerous, small, simple pits. Pith as large as a lead pencil.

Material: Yale No. 3682* (Guat.-Hond.). Other species: Yale No. 1790* (Braz.). Asterisk indicates botanical material.

CECROPIA

This genus, with about 60 species of small, soft-wooded trees, is widely distributed throughout tropical America. The two best known species are *Cecropia peltata* L. and *C. palmata* Willd. of the West Indies, the Guianas, and northern Brazil. They are trees 20 to 50 feet

high and 10 to 12 inches in diameter, with copious latex yielding a kind of rubber, and having a bark useful for tanning and as a source of fiber employed by the natives for cordage and rope. The light perishable wood has few uses except for purposes of buoyancy and kindling.

The stems of *Cecropia* are hollow, except for rather widely separated thin partitions, and are usually infested with ants and sometimes with small bees. In describing a trip up the Demerara River in British Guiana, Gleason[38] says: "Conspicuous in the bush along shore are the 'ite' and 'kokerite' palms, both productive of fruits valuable for their oil, and the tall slender stems of 'pumpwood,' surmounted by a cluster of huge leaves. The latter, under its generic name *Cecropia*, is well known to both botanists and entomologists for its interesting development of myrmecophily. The stems are hollow and divided into chambers by transverse partitions at each joint. Through a thin spot in the stem above each joint ants gain access to the interior and use the chambers for their nests. They open passages from one to the other and gradually move up as the tree grows taller, thereby keeping their activities near the summit of the stem. This habit is well known to the Indians, who carefully avoid handling the plants, or for that matter, any other plants which are habitually infested with ants, and long experience has made the Indians exceedingly wise in this respect."

There are various species of *Cecropia* in Brazil, at least twelve in the Amazon region, and they are generally known by the name of "imbaúba" or "embaúba." They are small, short-lived, rapid-growing trees, often forming almost pure stands along stream banks and the newly made flood plains of the rivers; they also quickly invade clearings in the forest. Usually they attain their full growth of 30 to 50 feet in height and six to eight inches in diameter in about five years. Occasional trees are found that are 60 feet high and 18 to 24 inches in diameter. The trunks are usually hoary with lichens, and the enormous peltate, divided leaves, often white beneath, and clustered at the ends of the few coarse candelabra-like branches, produce a very characteristic and striking effect. The ants which inhabit the twigs are not so ferocious as those of the *Triplaris* (Polygonaceae). The wood is used for making rafts, and also for fuel and charcoal, and in southern Brazil for match sticks. The bark supplies useful fiber and the latex has medicinal applications.

The "ambay" of Argentina, *Cecropia adenopus* Mart., is a tree about 40 feet high with a straight trunk upward of 20 inches in diameter, common on sand bars and alluvial flats. The large leaves are white on

[38] Gleason, H. A.: Botanizing in British Guiana, *Journ. N. Y. Bot. Garden*, 22: 261: 162, Sept., 1921.

the under side and are so rough that the tree is often called "palo de lija" (sand-paper tree). The dried leaves are reputed to be highly efficaceous in the treatment of bronchial and pulmonary diseases. The wood, which is not as soft and weak as that of the northern species, is used to a limited extent for paper pulp, box boards, and fuel.

THE WOOD

Cecropia adenopus Mart. *Ambaý.*

Common names: Ambaý, ambaí, palo de lija (Arg.). Other species: Trumpet tree, shake wood (Jam.); yagrume hembra, llagrumo, trumpet tree (P. R.); trompette (Guad.); bois canon (Fr. G.); pump wood, congo pump, trumpet tree, wanasoro (B. G.); guarumo, orumo, yarumo (Col.); imbaúba, embaúba, arvore da preguiça (Braz.); guarumbo, saruma (Mex.).

General properties: Light brown, pinkish or grayish; likely to be stained. Sapwood scarcely distinguishable.

Odor and taste absent or not distinctive.

Light and soft. Sp. gr. (air-dry) 0.44. Weight about 27 lbs. per cu. ft. Grain straight or fairly so. Texture coarse. Wood easy to cut, finishes rather smoothly, is tough and strong for its weight, holds nails well; perishable.

Growth rings: Sometimes distinct, due to more abundant local development of parenchyma; often indistinct.

Parenchyma: Abundantly developed about pores and connecting some of them into short to long, mostly irregular, tangential or diagonal chains; usually distinct; sometimes shows rather prominently on tangential surface, especially if stained.

Pores: Rather large and distinct; fairly numerous, but not crowded; fairly evenly distributed; occurring singly or subdivided radially two to several times; no definite arrangement except those that are joined by parenchyma bands; open.

Vessel lines: Long, straight, and coarse; distinct, but not very conspicuous, being of same color as background.

Vessel contents: None observed.

Rays: Distinct on cross section; faintly visible on tangential; conspicuous on radial surface, appearing darker than background.

Ripple marks: Absent.

Gum ducts: None observed. No latex tubes.

Minute anatomy: Vessels with large bordered pits. Rays heterogeneous; one to five cells wide, few to 35 cells high (in other species up to 100 cells high), the cells widely variable in size; pits into vessels large, irregular, half-bordered. Fibers large, thin-walled, arranged in radial rows; sometimes septate.

Remarks: Some of the lightest specimens of *Cecropia* suggest the heavier grades of balsa (*Ochroma*). Pith chamber in specimen (Yale No. 2891) from Curaçao, D. W. I., is 0.3 inch in diameter with the partitions 1.3 to 2.0 inches apart; in specimen (Yale No. 3970) from Colombia, the diameter is

about 0.7 inch and distance between septa 1.4 to 2 inches. Thickness of septa, 0.02 to 0.05 inches.

Material: Yale Nos. 1720*, 2526, 2527, 3977 (Arg.); 2891* (Curaçao); 1607*, 2534, 3970 (Col.). Asterisk indicates botanical material.

10. PROTEACEAE

The Silky Oak Family consists of about 50 genera and nearly a thousand species, all highly interesting plants and unsurpassed for ornamental purposes, but their economic usefulness is limited to a few fancy woods and a few edible nuts. The woods, of singular beauty, exhibit considerable variation in density and in depth of color, but in general they are characterized by conspicuously broad oak-like rays which show on the tangential surface as spindle-shaped masses in an irregular fiber meshwork. The pores are small and associated with parenchyma in concentric bands or more often in scallops.

Although largely Australian, this family is fairly well represented throughout the southern hemisphere. The best known tree is the Australian silky oak, *Grevillea robusta* A. Cunn., which has been planted in tropical and sub-tropical regions the world over, growing well in regions too dry for most other trees to thrive. Other species of *Grevillea* produce harder and deeper-colored woods, one of which is known as beefwood. Another Australian tree, *Macadamia ternifolia* F. Muell., is cultivated in Cuba on account of its edible nuts, "nuez de Queensland."

The family is abundantly represented in South Africa. The well-known silver tree, valued for decorative purposes, is *Leucadendron argenteum* R. Br. The flowers of the shrub or small tree called "zucker-bos" (sugar bush), *Protea mellifera* Thunb., contain such a large amount of watery nectar that the natives collect it and boil it down to make a delectable cough syrup called "zucker-bos-stroop."

There are six arborescent genera in South America, but their timber is not of much importance because of its small size and limited quantity. The "avellano," *Guevina Avellana* Mol., and the "radal," *Lomatia obliqua* R. Br., of Chile and Patagonia, supply woods well suited for furniture, carpentry, and construction. The only tropical American genus worth considering is *Roupala*.

ROUPALA

The genus *Roupala* (*Ropala*, *Rupala*, or *Rhopala*) consists of about 60 species widely distributed throughout Mexico, Central America, and South America, though most of them are Brazilian. The "páo concha,"

believed to be *R. brasiliensis* Kl., is fairly common, but not abundant, in the rain forests of Bahia, where it attains a height of 100 feet or more, with a trunk 24 to 30 inches through and upward of 50 feet free of limbs. The simple leaves are leathery and are noticeably different from those of associated trees in that they are dentate. The timber is highly durable and is employed locally in exposed structures, railway ties, and to a small extent for furniture and cabinetwork. The name "páo concha" (shellwood) presumably refers to the figure produced by the rays, and different kinds of the wood are designated according to their color. "Páo concha claro" is much softer than the "páo concha rôxo" and may belong to another genus but the differences are no greater than obtain in the various woods of *Grevillea*. There are species of *Roupala* in the lower Amazon region, but apparently they are mostly small trees of no economic value except possibly for firewood.

THE WOOD

Roupala brasiliensis Kl. (probably) *Páo Concha rôxo.*

Common names: Páo concha, páo concha claro, páo concha rôxo, páo concha rôxo escura, aderno, carvalho (Braz.); carne asada (Venez.). OTHER SPECIES: Carne-de-vaca, carvalho, cutucanhem, catucanhem, cutucanhée, sobro (Braz.); beefwood, guatapaná (Trin.); zorillo (Salv.).

General properties: Color reddish-brown to chocolate, sometimes with black streaks; flecked with the large rays. Sapwood the color of oak; sharply defined.

Odor and taste not distinctive.

Very hard and heavy. Sp. gr. (air-dry) 0.81 to 0.99. Weight 51 to 62 lbs. per cu. ft. Grain fairly straight. Texture coarse. Wood harsh and fibrous, not easy to cut, takes high polish, is very durable.

Growth rings: Apparently absent.

Parenchyma: In numerous lines stretched hammock-like from ray to ray and containing pores which usually protrude on the inner side.

Pores: Rather small to minute; the larger visible without lens, but not very distinct; not very numerous; appearing subdivided or grouped tangentially; arranged tangentially and often appearing as though hanging on the parenchyma lines.

Vessel lines: Inconspicuous.

Vessel contents: None observed.

Rays: Very large and conspicuous on all sections, composing a fourth to a third of the wood; color lighter than fibers on cross section, but darker on longitudinal surfaces except in the dry, dark-colored specimens; very prominent oak-like figure on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; intervascular pits

minute, crowded, with anastomosing pit mouths giving appearance of spirals. Rays of two kinds: (1) very large and homogeneous, predominating; (2) uniseriate and only one or two cells high, the cells vertically elongated; pits into vessels very small, half-bordered. Parenchyma abundant in laminae containing vessels. Fibers thick-walled; pits small and indistinct, with circular border and slit-like aperture.

Remarks: A wood called "páo concha claro" (Yale No. 3532) is of much the same structure as the above, but it is comparatively light and soft (sp. gr. 0.59), easy to cut, and not harsh; the parenchyma lines are very closely spaced and mostly independent of the pores. It resembles the silky oak of Australia, only the parenchyma lines are much more numerous, and is apparently the same as a specimen labeled "saqui saqui" (Yale No. 353) from Venezuela. A specimen of "aderno" (Yale No. 3467) has a specific gravity (air-dry) of only 0.54. An Amazon specimen (Yale No. 5948) labeled "louro faia" belongs to this group and has a specific gravity (air-dry) of 0.64.

Material: Yale No. 1802 collected with sterile botanical material by Curran in Bahia, Brazil, under the name of "aderno"; also 3313, 3467, 3528 A, 3529, 3580, 5948 (Braz.).

11. OLACACEAE

This family consists of about 27 genera and 150 species of trees, shrubs, and woody vines widely distributed in tropical regions, but of little economic importance. There are 10 arborescent genera in tropical America, but the trees are small.

XIMENIA

Of the nine or ten species of this genus the best known and most widely distributed is *Ximenia americana* L., sometimes a tree 30 feet high and 18 inches in diameter, but more often a shrub, occurring in tropical and sub-tropical regions throughout the world. It is armed with sharp spines, has a dark red astringent bark useful for tanning, and bears edible plum-like fruits from which hydrocyanic acid can be obtained. The seeds are rich in oil. The fragrant, reddish-yellow wood is fine-textured and very hard and heavy; sp. gr. (oven-dry) 0.92 (Tenth Census). Weight about 57 lbs. per cu. ft. The wood is little used except for fuel and charcoal. In India it is sometimes employed as a substitute for sandalwood.

Common names in tropical America: Hog plum, mountain plum, Spanish plum, tallow-nut, wild lime, wild olive, false sandalwood, yellow sanders (Fla., B. W. I.); ciruelillo, ciruelo cimarrón, jía manzanilla, yaná (Cuba); croc (S. D.); oranger des falaises, prunier épineux (Guad.); oranger montagne (Fr. G.); heymassoli (Galibis); seaside plum (Trin.); ameixa, ameixa

de espinha, ameixeiro, espinha de meicha (Braz.); albaricoque, albaricoquillo, abriboquillo de campo, albarillo, albarillo de campo, pata (Arg.); xkuk-ché (Mex.); pepe nance, manzanillo (Salv.); chocomico (Nic.); manzanilla (Guat., Hond.); limoncillo (Col.).

MINQUARTIA

This genus, the most important of the family, consists of a single species, *Minquartia guianensis* Aubl. (= *Secretania loranthoides* Muell. Arg.) of the Guianas and northern Brazil. Some botanists include it in the family Bignoniaceae, but the structure of the wood indicates that it does not belong there.

Huber[39] says that it is the only one of the several representatives of the family in the Amazon region known to produce useful timber. It has the disadvantage, however, not only of being small, but also of having a very irregular and deeply fluted trunk of so peculiar a shape that the species is recognizable at first sight. On account of this poor timber form, the dense, yellowish-gray, highly durable wood is limited in its application, being chiefly used for rural house posts.

THE WOOD

Minquartia guianensis Aubl. *Acaricuára.*

Common names: Acaricuára, acaricaára, acaricoára (Braz.); arata, konthout (Sur.); minquar (Guiana).

General properties: Color dull grayish-brown. Sapwood lighter; rather sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.98. Weight about 61 lbs. per cu. ft. Grain straight. Texture medium. Wood fairly easy to work, takes a smooth finish, splits easily in radial plane, appears durable.

Growth rings: Sometimes fairly distinct, but not sharply defined; due mainly to absence of parenchyma.

Parenchyma: In very numerous, very fine, irregular lines making a net work with the rays; not individually visible without lens, but zones in which they are absent appear denser.

Pores: Pores small; in short radial rows which are readily visible; fairly numerous; well distributed; closed.

Vessel lines: Visible, but inconspicuous.

Vessel contents: Tyloses abundant; lustrous.

Rays: Extremely fine and numerous; not visible without lens on cross and tangential section; visible, but inconspicuous, on radial surface, appearing of same color as the background.

Ripple marks: Absent.

Gum ducts: None observed.

[39] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 172 (1909).

Minute anatomy: Vessels have scalariform perforations with eight to ten bars each. Rays uniseriate and mostly high; decidedly heterogeneous; cells coarse, gummy; pits into vessels very large, rounded or elongated and scalariform, simple to half-bordered. Wood fibers thick-walled with inconspicuous simple pits.

Remarks: The structure of the wood resembles that of certain of the Euphorbiaceae. Not all of the woods of the family have scalariform perforations between the vessel segments; for example, they are simple in *Anacolosa,* but scalariform in *Strombosia.*

Material: Yale Nos. 4013 (Braz.); 4167 (Sur.).

12. POLYGONACEAE

The Buckwheat Family consists of about 40 genera and upward of a thousand species that are mostly herbaceous plants of the temperate zone, though there are some trees, shrubs, and woody vines in tropical regions. The trees are largely confined to three genera of the western hemisphere, namely, *Coccoloba, Triplaris,* and *Ruprechtia.* Their woods are used only locally and do not enter the export trade.

COCCOLOBA (COCCOLOBIS)

There are over 150 known species of this genus, distributed throughout the tropical and sub-tropical regions of America. The pigeon plum, *Coccoloba laurifolia* Jacq., is one of the largest and most abundant of the tropical trees of the seacoast of southern Florida where it attains a height of 60 to 70 feet, with diameters up to two feet. It is common also in the West Indies and along the northern coast of South America. More widely distributed and better known is the sea grape, *C. uvifera* L., which occurs on sandy or rocky sea beaches of Florida, the West Indies, northern and eastern South America, both coasts of Central America, and down to Peru. In Cuba and Jamaica, where it is at its best, it also grows in the moist woods of the interior at elevations of 500 feet or more. At the limits of its range and in poor situations it is only a shrub or a low densely branched tree, but in better sites it is from 25 to 60 feet high and 18 to 24 inches in diameter. It has large rounded leaves that are very thick and leathery, and bears clusters of purple grapes that are good to eat, although the stone is large in proportion to the flesh. The bark yields, upon excision, an astringent red juice which is the source of the West Indian kino. This product, known also as gum kino, American kino, American extract of rhatany, and false rhatany extract, was formerly an article of trade, but the kino of commerce is now supplied by West Africa and parts of the East Indies.

Because of the limited number of large trees, the timber is used very little except in Jamaica and Cuba where it is in demand for cabinet work and furniture, for which it is well suited. Owing to the similarity of names, *Coccoloba* is sometimes confused with the cocobolo wood of commerce.

THE WOOD

Coccoloba uvifera L. *Sea Grape.*

Common names: Sea grape, seaside grape, mangrove grape, seaside plum, pigeon wood, horsewood, hopwood, West Indian kino tree (Fla., B. W. I.); uvero (Sp., gen.); uva del mar (P. R., Trin.); uva caleta, uvero (Cuba); uva, uvillo (S. D.); raisinier du bord de mer, raisinier de plage (Fr. W. I.); bois baguette, raisinier à grappes, raisinier à fruits, peuplier d'Amérique (Fr. G.); druif, zee-druif (Sur.); uvero de playa, papaturro (C. A.); uva, uva del mar, uva, de la playa, uvero, manzano (Mex.); guajabara (Braz.); dreifi (D. W. I.); Other species: Pigeon plum, tie-tongue, bow-pigeon, crabwood, stavewood (B. W. I.); ortegon, morelon, calambreñas, uvillo, uverillo, cucubano, gateado, glateado, palo bobo (P. R.); uvero macho, yarúa, manati (Cuba); bois baguette, Saint-Jean, bois rouge montagne, raisinier à grandes feuilles (Fr. G., Fr. W. I.); bradi lifi (Sur.); coemari, dreifi, kamalia (D. W. I.); uvero del monte, cuchape (Trin.); cauassú, tinteira, pichuna, arco de pipa (Braz.); cocobolo (Peru); duraznillo morado (Arg.); carnero, carnero de la costa, palo de carnero, tamulero, tepalcahuite, tocó prieto, uvero (Mex.); irire, juril, papalón, paparrón, papaturro (Salv.).

General properties: Color red or dark brown tinged with red; sometimes violet; may be streaked. Sapwood pinkish; rather sharply defined.

Odorless. Taste slightly astringent. Alkaline extract ruby-red.

Hard, heavy, and compact. Sp. gr. (oven-dry) 0.96 (Tenth Census). Weight about 60 lbs. per cu. ft. Grain irregular. Texture fine. Fairly easy to work, takes high polish, looks durable; is strong, but brittle.

Growth rings: Present or absent; usually poorly defined.

Parenchyma: Present as numerous scattered cells; sometimes of white color showing distinctly against dark background; sometimes not visible with lens.

Pores: Mostly very small, not always visible without lens; few; scattered; occurring singly or more often in short radial rows.

Vessel lines: Fine and inconspicuous.

Vessel contents: Some dark gum deposits noted.

Rays: Extremely fine; barely visible on cross and tangential sections with hand lens; fine and inconspicuous on radial.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: In some species there is a more or less pronounced tendency for the parenchyma to be arranged in concentric lines (*e.g.*, Yale Nos. 2732, 3021).

Minute anatomy: Vessels with simple perforations; intervascular pits of

Photo by C. D. Mell.

West Indian Kino Tree.

(Coccoloba uvifera.)

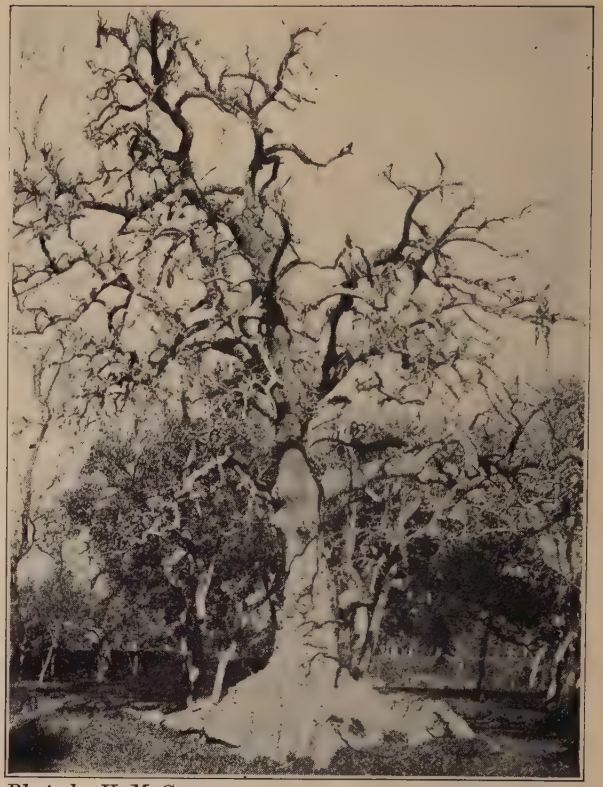


Photo by H. M. Curran.

The Ombu of Argentina.

(Phytolacca dioica.)

PLATE XXIII

screwhead type, comparatively large, crowded. Rays heterogeneous; uniseriate; cells coarse and gummy; pits into vessels open-mouthed, half-bordered. Chambered parenchyma strands with large crystals common. Fibers thick-walled, with minute simple or indistinctly bordered pits.

Material: Yale Nos. 2753*, 2769* (Curaçao); 2687, 4632 (P. R.); 5183*, 5184*, 5185* (Florida). Other species: Yale Nos. 2713, 4546, 4592 (P. R.); 2732*, 2791* (Curaçao); 3121* (Pan.). Asterisk indicates botanical material.

TRIPLARIS

This genus consists of about 40 species of small trees and shrubs occurring from Mexico through Central America to various parts of tropical and sub-tropical South America. They are of peculiar interest because their hollow stems are occupied by hosts of venomous war-like ants which emerge quickly and rain down on an intruder upon first contact with the tree. Because of the inviolability thus attained, the tree is often known as holy pole, or some native equivalent such as "vara santa" (Pan.), or "palo santo" (Peru, Col.). Other names refer to the ants. The wood is little used, although of excellent pine-like quality and suitable for general construction, especially interior work, and carpentry of all kinds.

The Long John, *Triplaris surinamensis* Cham., is a slender tree occurring in lowlands in the Guianas, sometimes composing nearly pure stands a few acres in extent and being one of the first trees to enter clearings. According to Spruce[40] it is common along the Amazon and is a "tree of very rapid growth, reaching at maturity a hundred or more feet in height, and conspicuous from afar when in fruit from the abundance and bright red color of its enlarged shuttlecock-like calyces." *T. caracasana* Cham. is found along the northern coast of South America and in Central America, being a common tree in old clearings. It is slender, straight, sparsely branched, and deciduous, and is rarely over 35 or 40 feet high and 12 to 16 inches in diameter. At a distance its smooth flaky bark has the general appearance of sycamore (*Platanus*).

THE WOOD

Triplaris caracasana Cham. *Ant Tree.*

Common names: Ant tree (Eng.); vara santa, palo hormiguero, guayabo hormiguero (Pan.); tabaco, hormigo (C. R.); palo maría barrabas (Venez.); palo santo (Peru). Other species: Long John (B. G.); tachy preto, tachy-zeiro, formigueira (Braz.); mierenhout, mirahoudou (Sur.); bois fourmi (Mart.); sapahaka-apolli (Galibis); palo santo (Col.); palo mulato (Mex.); canilla de mula, gallito, palo mulato (Salv.).

[40] Spruce, Richard: *Notes of a botanist on the Amazon and Andes*, vol. II, p. 402.

General properties: Color yellowish with a reddish tinge; rather lustrous. Sapwood cream-colored.

Odor and taste absent or not distinctive.

Rather light and soft, but firm. Grain straight or fairly so. Texture medium. Wood easy to work, finishes smoothly, takes good polish, does not appear durable, lacks figure.

Growth rings: Present but not always distinct; due to layer of somewhat denser wood.

Parenchyma: Very sparingly developed about pores; not visible with lens. The concentric lines or bands which show fairly distinctly under lens on moist cross section are aggregates of crystal-bearing wood fibers.

Pores: Small, but readily visible; fairly numerous, but not crowded; well distributed; occurring singly or more often in radial groups of two or three.

Vessel lines: Rather fine, but distinct; appearing somewhat darker than background.

Vessel contents: Some tyloses present.

Rays: Very fine; not visible without lens on cross and tangential sections; visible, but fine and inconspicuous, on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessel perforations simple; pits large, often elongate-elliptical, with large mouths; membranes with sieve-like structure. Pits between vessels and parenchyma large, half-bordered, with transitions to simple. Rays homogeneous. Fibers small, short (about 0.70 mm.), with numerous simple pits; septate and often chambered and containing small rhombohedral crystals.

Material: Yale No. 3011 collected by Dr. Pittier in Panama; his No. 141. Other species: Yale No. 5111 (B. G.).

RUPRECHTIA

This genus, which closely resembles the preceding, consists of about 30 known species of trees and shrubs widely distributed through tropical America from Mexico through Central America into various parts of South America. The only material available is from Argentina where there are several species of tree size, some of them attaining a height of from 60 to 75 feet and a diameter up to two feet, though usually smaller. The fact that these trees are known by some of the same local names applied to *Pterogyne nitens* Tul., a beautiful cabinetwood of the Leguminosae, probably accounts for the discrepancies found in certain published descriptions, although the woods are wholly unlike. Judging from the specimens at hand, the wood of *Ruprechtia* varies from rather soft, suggesting willow (*Salix*), to rather hard, suggesting birch (*Betula*). The uses reported include general construction, carpentry, joinery, interior finish, flooring, furniture, implements, tool handles, fuel and charcoal.

THE WOOD

Ruprechtia sp. *Virarú.*

Common names: Virarú, virarú colorado, viraró, ivaró, ibiraró-mi, ibirá puitá, ibirá-puitá-y-rá, ibirá-pyitá, ibirá-pita-bi, ibirá hembra, lata, palo estaca, palo barrosa, palo de lanza, higuerita, marmelero, manzano del campo, manzanillo, mata negra, rama negra, sacha manzana, duraznillo colorado, sarandí negro (Arg.); virarú, guayuvira (Braz.).

General properties: Color light pinkish or reddish-gray; often with narrow reddish streaks like pith flecks; luster low. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Moderately hard, heavy and compact. Sp. gr. (air-dry) 0.66. Weight about 42 lbs. per cu. ft. Grain straight or fairly so. Texture fine. Wood easy to work; takes a smooth finish, tough and strong, probably not durable.

Growth rings: Fairly distinct on all sections, due to differences in density.

Parenchyma: Sparingly developed about pores; not visible with lens. Lines resembling parenchyma, but composed of crystal-bearing wood fibers, rarely present.

Pores: Small to minute; not always visible without lens; variable from few to rather numerous; not crowded; occurring mostly in radial groups of two or sometimes in short radial lines.

Vessel lines: Fine, but often distinct, being of somewhat deeper color than background.

Vessel contents: None observed.

Rays: Very numerous, extremely fine; scarcely distinct under lens on cross and radial sections; visible, but fine and scarcely distinct, on radial surface. Homogeneous.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pit membranes perforated. Rays homogeneous; uniseriate; few to 20 cells high; pits into vessels half-bordered, with open mouths. Fibers septate; some containing fine rhombohedral crystals.

Remarks: The wood is harder, of lower luster, and less fissile than that of *Triplaris.*

Material: Yale Nos. 970*, 997*, 1007*, 1043, 3996, 6244 (Arg.). Asterisk indicates botanical material.

13. NYCTAGINACEAE

This family consists of about 25 genera and several hundred species, mostly herbs in temperate regions, and shrubs and small or medium-sized trees in the tropics. Some of the plants are highly decorative, and the *Bougainvillea* of South America is widely cultivated in gardens. The family does not produce any commercial timber, but the woods are interesting in that they are characterized by anomalous structure of the

Strychnos type, soft bast being included in the wood in the form of strands which appear on the cross section as numerous small islands comprising about half the area. The best known arborescent genus is *Pisonia.*

PISONIA

This genus consists of 100 species, mostly shrubs, many of them thorny, some woody vines, and a few trees. There are several representatives in the Far East and at least three of tree size in Hawaii, but the most of the species are South American. An Indian species, known as the lettuce tree, bears edible leaves which are used as salad. The wood of the "joão molle" of Brazil, *Pisonia tomentosa* Casar, is said to be used to a limited extent for agricultural implements and more commonly for fuel.

The largest tree is the "zapallo" of Argentina, *P. Zapallo* Gris., which is fairly common in the northern part, where it attains a height of from 60 to 70 feet and a diameter up to three feet. The wood is light (sp. gr. 0.45), soft, spongy, but tenacious, and finds many local uses such as for stable floors, sabots, cooperage, boxes, canoes, and paper pulp. It also serves for fuel, and the ashes are rich in potassium salts.

Two West Indian species extend into southern Florida and one of them, the blolly, *P. obtusata* Jacq., is a tree 30 to 50 feet high with an erect or inclining trunk 15 to 20 inches in diameter. Since the only authentic wood specimen available is of this species, it will be used as the type. It is almost identical with a Brazilian wood (Yale No. 3594) called "joão dormido."

THE WOOD

Pisonia obtusata Jacq. *Blolly.*

Common names: Blolly, pigeon wood, beefwood, corkwood, pork wood (Fla., B. W. I.). Other species: Corcho, palo bobo (P. R.); mapoa gris (Guad.); joão dormido, joão molle, cebolino (Braz.); zapallo, zapallo-caspi, yuquerí-buzú, yukirú-ruzú, yukerí-sy, yukerí-ruzú-rá, yaguá-pinda, ombú-ra, palo bobo (Arg.); cagalero negro, crucito, espuela del diablo, guaco (Salv.); casabe (Venez.).

General properties: Color dark gray; lusterless. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Moderately light and soft. Sp. gr. (oven-dry) 0.65 (Tenth Census). Weight about 40 lbs. per cu. ft. Grain fairly straight. Texture very coarse. Wood not easy to work; fibrous, suggesting palm; will not finish smoothly.

Growth rings: Absent or indistinct.

Parenchyma: Sometimes visible with lens as few fine tangential lines.

Pores: Very small; not visible without lens; in short radial groups. The

larger and distinct pore-like structures are cross sections of the bast strands, which are rounded or diamond-shaped, very numerous, evenly spaced, sometimes more or less united into diagonal rows; about equal in width to the fiber layers between them.

Vessel lines: Very fine and indistinct. The bast strands are very numerous and distinct and resemble large vessels.

Vessel contents: None observed. The bast strands look like vessels filled with tyloses. Lustrous crystals also present.

Rays: Extremely fine; interrupted by bast strands; not visible without lens on cross and tangential sections; indistinctly visible on radial.

Ripple marks: Present or with tendency to their formation, due to storied fibers mostly; fine and rather irregular; not visible without lens and scarcely distinct with it.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits minute, crowded. Rays homogeneous or nearly so, uniseriate and low, rather coarse-celled; pits into vessels half-bordered, the parenchyma cell portion being elongated either vertically or horizontally to include from two to four normal-sized pits in the vessel. Parenchyma cells common, diffuse. Fibers with simple, inconspicuous pits.

Remarks: Hawaiian specimens have similar structure, but are coarser, and when bast decays the fiber strands tend to fall apart. A Brazilian specimen labeled "cebolino" (Yale No. 3641) has fewer and larger strands than the type and ripple marks are absent; its identity is uncertain.

Material: Yale No. 5225 (Fla.).

14. PHYTOLACCACEAE

The Pokeweed Family consists mostly of herbs, of which our common pokeweed or pokeberry is a familiar example, but there are a few tropical representatives that are shrubs or trees. Some of the trees are rather conspicuous in parts of the South American forests, but from a commercial standpoint are of very little importance. The woods are typically light and soft, and characterized by an anomalous structure, being composed of alternate layers of wood and bast. The bast, being of pith-like consistency, forms such a weak connective between the woody layers that they can be readily separated like the layers of an onion. As to the minute anatomy: The vessel perforations are simple. The rays are variable in width and the pits into the vessels are bordered, wholly or in part. The wood fibers, for the most part, have simple pits.

PHYTOLACCA

The "ombu" or "umbu," *Phytolacca dioica* L., is found in all parts of Argentina, being practically the only large tree in the Pampas

region, and also occurs, though less abundantly, throughout the southern half of South America, and has been also introduced into many countries of the Old World. In Argentina it attains a height of 50 feet or more and a diameter of over three feet, and is of value for shade and decorative purposes. It grows rapidly and reproduces itself so readily by sprouting that it is difficult to eradicate, resembling the *Ailanthus* in this respect. The tree occupies a prominent place in the literature, especially the poetry, of Argentina, as the "ombu" is reputed to work an evil magic on the unwary who sleep beneath its boughs. The wood is light, soft, spongy, and laminated, tending to fall to pieces when dry; it is not utilized. (Plate XXIII.)

GALLESIA

The "páo d'alho," *Gallesia Scorododendrum* Casar. (= *G. Gorazema* Moq.), is very common in the dense coastal rain forests of the Bahia-Victoria region, and is also credited to Peru. It is of rapid growth and reaches a height of 125 feet and a maximum diameter of 10 feet, the large trunks being characteristically fluted, contorted, and usually hollow. The trees are very tenacious of life and sprout so freely and persistently that they attain a rank in the second-growth forest entirely incommensurate with their importance. When in blossom and more especially when the timber is being cut, the forest reeks of garlic, whence the name "páo d'alho" or garlic wood. The timber is not used in the southern part of its range where other kinds are abundant, but farther north where the forests have been depleted it finds a place in rough construction.

THE WOOD

Gallesia Scorododendrum Casar. *Páo d'Alho.*

Common names: Páo d'alho, guararema, ibirarema (Braz.); garlic wood.

General properties: Color white or dirty white; little contrast between heart- and sap-wood; liable to blue stain.

Odor of garlic very pronounced when fresh, tending to disappear upon drying. Taste unpleasant.

Wood light and rather soft. Sp. gr. (air-dry) 0.58. Weight about 36 lbs. per cu. ft. Grain irregular. Texture coarse and uneven. Wood easy to cut, but difficult to finish smoothly because of the laminated structure.

Growth rings: Conspicuous, due to thick white spongy layers which occasionally anastomose. Just inside this layer is a single row of openings resembling pores or canals—the phloem cavities. Wood consists of alternate concentric rows of wood and bast, an anomalous structure of the *Avicennia* type.

Parenchyma: Wood parenchyma not in evidence. Concentric zones of bast, varying in width from 0.02 to 0.06 inch and resembling wood parenchyma, very conspicuous.

Pores: Small, indistinct to invisible; occurring singly, in pairs, or in short radial lines; not crowded; pretty well distributed. Phloem openings, which may be mistaken for large pores, are in single rows between layers; very distinct.

Vessel lines: True vessel lines indistinct, fine and wavy. Phloem cavities very distinct; conspicuous on tangential surface.

Vessel contents: Tyloses present.

Rays: Fine to rather broad; the latter very distinct on cross section; widening at white layers, and appearing of lighter color than fibers; indistinct on tangential where (under lens) they exhibit considerable variation in height; distinct on radial surface in proper light.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; intervascular pits large with lenticular mouths. Rays decidedly heterogeneous; widely variable in size; pits into vessels large, simple, oval. Wood parenchyma scantily developed. Wood fibers with small simple pits; some of the cells septate.

Material: Yale No. 1780* and 5278 (Braz.). Asterisk indicates botanical material.

15. MAGNOLIACEAE

The Magnolia Family, consisting of about 14 genera, is well known in nearly all parts of the world. Many of the trees and shrubs have large showy and often sweet-scented flowers and are accordingly in demand for decorative purposes; the flowers of some species are the source of essential oils used in making perfumes. The best known of the timber trees is our yellow poplar or tulip-tree, *Liriodendron tulipifera* L., which furnishes one of the most useful woods on our market. There are several genera in the Far East, and some of the species are of considerable local importance for their woods. The three arborescent genera in tropical America are *Magnolia*, *Talauma*, and *Drimys*.

The woods of this family are alike in being rather fine-textured, moderately soft, mostly straight-grained, easy to work, and well adapted to general carpentry. The four genera *Drimys*, *Zygogynum*, *Trochodendron*, and *Tetracentron* are remarkable in that they are the only known members of the woody dicotyledons without true vessels in their woods, their structure being in this respect similar to that of the conifers. In the others the vessel perforations are characteristically scalariform, some with few and some with many bars, and the wood fibers have bordered pits. Scalariform bordered pits are common in the vessels and tracheids.

MAGNOLIA

This genus consists of many species of trees and shrubs occurring in temperate and tropical regions of both hemispheres and widely used in

ornamental planting. The largest of our native species is the cucumber-tree, *Magnolia acuminata* L., the wood of which is not always readily distinguished from that of *Liriodendron*.

The genus is of limited occurrence in tropical America, although there are species in Mexico, Central America, and the West Indies. *Magnolia splendens* Urb. is one of the best timber trees in Porto Rico, where it is known as "laurel," "laurel sabino," or "sabino." The name "laurel," more commonly applied to members of the Lauraceae, refers to the spicy fragrance of the essential oil of the tree. It inhabits all parts of the island and has been known to attain a height of 100 feet and a diameter of 30 inches, with good timber form. The wood is of an olive-brown or yellowish-green color, straight-grained, fine-textured, firm and strong, very similar in all respects to our yellow poplar, and is suitable for the same purposes. It is so much in demand locally that the tree has become very scarce.

TALAUMA

This genus, of which over 40 species are known, occurs generally throughout the tropics. Most of the trees are small or medium-sized, but some of them attain large dimensions. The wood is much like that of *Magnolia* and *Liriodendron*, but is of limited utility because of its scarcity. Its uses include general carpentry, buildings, especially the interior work, boxes of all kinds, shelves, drawers, canoes, and paper pulp. The bark has medicinal properties and the flowers are used for making perfumes.

The distribution of this genus in the New World includes the West Indies, Mexico, Central America, Colombia, Venezuela, Brazil, and the Guianas. The "pinho do brejo," *Talauma ovata* St. Hil., of Brazil, is a common tree in the bottom lands throughout the country, growing to a height of about 60 feet. It has large shiny leaves, showy white flowers, and fleshy pineapple-like fruits about the size of an orange. *T. mexicana* (DC.) Don is one of the best known of the Mexican trees, occurring in the mountains of Vera Cruz, Oaxaca, Mexico, and Morelos, sometimes attaining a height of 100 feet and a diameter of five feet. The flowers are large and white and so fragrant that a single blossom is sufficient to perfume a whole house.

There is little available regarding the several other species in tropical America, but the woods are apparently much alike in every way. That of a recently described species in Panama, where it attains a large size (90-120 feet high), will serve as a type.

THE WOOD

Talauma sambuensis Pittier *Magnolia.*

Common names: Magnolia, kakuábiuí (Pan.). Other species: Yorocónte (Guat.-Hond.); flor de corazón, guiclachi, hierba de las mataduras, hualhua, laurel tulipán, yoloxochitl, yolosuchil (Mex.); pinho do brejo, pinheiro do brejo, magnolia do brejo, magnolia do matto, canella do brejo, araticum fruta de páo, páo pombo (Braz.); bois pin, cochiman de montagne (Mart.); coeur de cachiman or cachiment (Guad.); magnolia (Cuba).

General properties: Color variable; yellowish, olive, or purplish; split surface lustrous. Sapwood gray; sharply defined.

Odor and taste absent or not distinctive.

Wood rather soft, but firm; straight-grained; medium-textured; easy to work; fairly durable. In appearance and properties it closely resembles *Liriodendron,* but is not so fine-textured.

Growth rings: Distinct; due to narrow bands of terminal parenchyma.

Parenchyma: In concentric lines or narrow bands limiting growth rings; sometimes two or three close together; visible, but not conspicuous.

Pores: Small, but visible; fairly numerous, but not crowded; well distributed; no definite arrangement; occurring singly or often as though subdivided radially (and rarely tangentially) one to three times; open.

Vessel lines: Fine, long, inconspicuous scratches. Scalariform perforations visible on radial section with good lens.

Vessel contents: Tyloses present.

Rays: Fine, but visible, in cross section; invisible or nearly so on tangential; fine, but distinct, on radial, where the individual cells are large enough to be seen with good hand lens, many of the cells being square or upright.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels have scalariform perforations with several coarse bars; intervascular pits commonly scalariform; no spirals observed. Rays heterogeneous; mostly three to five cells broad; pits into vessels very large, simple or with very narrow border, and often greatly elongated and in scalariform arrangement. Parenchyma terminal in two to four seriate layers. Fibers with small bordered pits.

Remarks: In a specimen (Yale No. 3712*) of "yorocónte," *Talauma* aff. *poasana* Pittier, the pores are somewhat fewer and larger, some of them showing the bars of the perforations clearly under the hand lens. Sp. gr. (air-dry) 0.55.

Material: Yale No. 2974 from type tree collected by Dr. Pittier in southern Darién, Panama, in 1912; his No. 5681.

DRIMYS

There are several species of this genus in Australia, New Zealand, and Borneo, but they are mostly shrubs and of no commercial importance. There are a few species in the New World and one of them,

Drimys Winteri Forst., with its varietal forms, has a range including Mexico, Central America, and most of South America. Usually it is a small tree, sometimes scarcely more than a shrub, but under favorable conditions it attains a height of 80 feet. The flowers are fragrant and are used to make perfumes. The purplish-black fruits, which are small and borne in corymbs, suggest *Viburnum*. The tree is best known on account of its bark.

Standley[41] says: "This plant, which furnishes the Winter's bark of commerce, was first obtained by Winter, who was captain of one of the ships which accompanied Sir Francis Drake's expedition of 1577. The three vessels of the fleet were struck by a storm in the southern ocean and Winter's ship was driven to the Straits of Magellan, where three weeks were spent with the object of improving the health of the crew. *Drimys* was one of the plants which attracted Winter's attention, and he used the bark for treating scurvy. Specimens of the bark were presented to the famous botanist Clusius, who gave it the name of Cortex Winteranus. It became a favorite remedy in Europe, but as it was difficult to obtain the drug from South America the bark of *Canella alba*, a West Indian tree, was often substituted for it. Winter's bark is little used at the present time except in domestic medicine in the regions where it is native. It is aromatic and pungent and has toxic and anti-scorbutic properties. In Brazil it is used for dysentery and for gastric disturbances. In Costa Rica the bark is chewed for toothache. The powdered bark is sometimes employed in Mexico as a condiment."

The wood, which looks like beech (*Fagus*), has the consistency of basswood (*Tilia*) and is used locally for boxes, cases, interior woodwork, and miscellaneous purposes not requiring a very strong or durable material.

THE WOOD

Drimys Winteri Forst. *Winter's-bark Tree.*

Common names: Winter's-bark tree (Eng.); chachaca, chilillo, palo de Chile, palo picante (Mex.); muelo, quiebra-muelas (C. R.); canelo de páramo, quinon, palo de agi (Col.); arbol de agi (Venez.); ecorce-de-tapir (Fr.); casca de anta, casca d'anta, carne d'anta, casca de Winter, paratudo, páo para-tudo, melambo, canella amarga, canella de paramo, cataia, capororoca (Braz.); canelo (Chili); kanelo, palo de mambo (Arg.).

General properties: Color light brown or pinkish; suggesting beech. Sapwood grayish; not sharply defined.

Odor and taste absent or not distinctive.

Wood light, but firm, suggesting basswood. Sp. gr. (air-dry) 0.50. Weight about 31 lbs. per cu. ft. Grain straight or fairly so. Texture fine and uniform.

[41] Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.*, 23: 2:276 (1922).

Wood easy to work, of rather cheesy consistency, tough and strong for its weight, holds nails well; not durable.

Growth rings: Indistinct to fairly distinct; due to slight difference in color.

Parenchyma: Not visible.

Pores: Absent. The structure resembles that of a uniform-textured conifer, except for the size of the rays.

Vessel lines and contents: Absent.

Rays: Variable in size, but many of them rather large and distinct on all sections, suggesting beech; prominent on radial section, being considerably darker than background, and producing silver grain.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels absent. Tracheids arranged in regular radial rows; pits in one to four rows on radial walls, and have large circular borders and lenticular mouths, sometimes slit-like and extending beyond border. Rays one to seven cells wide and few to 100 cells high; most of the cells square or upright; pits into tracheids smaller than those between tracheids, with circular border and slit-like aperture; pits between ray cells very abundant and irregular.

Remarks: The structure is much like that of *Trochodendron aralioides* S. & Z. of Formosa (specimen No. 2, Kanehira's collection), except that the growth rings are much less distinct.

Material: Yale Nos. 3751, 3769, 3770 (Chile).

16. ANONACEAE

The Custard-apple Family, which includes our common pawpaw, *Asimina*, consists of about 48 genera of trees and shrubs, nearly all of them tropical. There are many representatives in the Indo-Malayan region, there being 21 genera in India, at least 13 in Java, and 12 in the Philippine Islands. The best known is *Canangium odoratum* Baill., which is extensively cultivated for its very strongly scented flowers, from which the famous "ilang-ilang" perfume is obtained. The woods of several genera in the Philippines are known without distinction as "white lanutans," and, according to Schneider,[42] are much alike in general character, being light to moderately heavy, soft to moderately hard, of rather fine texture and straight grain, of whitish, pale yellow or light brown color, staining easily in drying, sometimes having a small, irregular, dark-colored heartwood, and all showing in cross section the conspicuous ladder-like pattern of soft tissue characteristic of the family. Most of timbers are not very durable in contact with the ground or exposed to weather, but are not commonly attacked by insects.

[42] Schneider, E. E.: Commercial woods of the Philippines: Their preparation and uses, *Bul.* No. 14, Phil. Bu. For., 1916, p. 106.

Though used locally for house construction and minor articles, they are rarely seen in commerce except in mixed lots of miscellaneous lumber. These statements apply almost equally well to the representatives in the western hemisphere.

There are fifteen or more genera in tropical America, but very little information is available regarding most of them. They are generally small trees occupying a minor position in the forest, and the only timber of commercial importance is the lancewood, *Oxandra lanceolata* (Sw.) Baill. In the Amazon region of Brazil, according to Huber,[43] there are many species of the genera *Anona*, *Duguetia*, *Guatteria*, *Rollinia*, and *Anaxagorea*, but they are mostly small, slender and rod-like trees, although a few are larger. The woods, commonly known as "envira,"[44] are at present little used.

ANONA (ANNONA)

This genus contains many species of small trees and shrubs which are confined almost exclusively to tropical and sub-tropical America, though the range of many species has been greatly extended through cultivation. Their principal value lies in their edible fruits, some of which are large and succulent, and variously known to English-speaking people as custard apple, sugar apple, sweetsop, soursop, bullock's heart, etc. The wood varies from light and soft to moderately so, has distinct rays and the usual arrangement of parenchyma. It is rarely used except for fuel and miscellaneous minor purposes. The bark of some species yields a fiber useful for cordage.

One of the best known species is *Anona glabra* L., a tree sometimes 40 to 50 feet high with a short trunk often 18 inches in diameter above the swollen or buttressed base. It is common in southern Florida and the West Indies and often forms pure forests in swampy lands near the shore. The wood, especially that of the roots, is very light and cork-like and is used as floats of fishing nets and for stoppers of bottles. Its common names are: Pond apple, corkwood (Eng.); bagá, palo bobo (Cuba); guanábano de corcho (S. D.); cayur, corazón cimarrón, guanábano cimarrón, anón (P. R.); anonillo (Guat., Hond.); corcho, árbol de corcho, palo de corcho, mag (Mex.).

It seems likely that some woods have been incorrectly referred to this genus. Thus the "arrewewa" or "ariwiwa" of the Guianas, which is supposed to be *Anona* sp., is said to be very hard, heavy (sp. gr. 1.11), fine-textured, and strong, and used for ax handles, beams, and other

[43] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:173 (1909).

[44] The name "envira" is applied also to species of *Sterculia*, *Guazuma*, *Luehea*, *Hibiscus*, *Caraipa*, *Lecythis*, etc.

purposes requiring strength. The "howadanni" of British Guiana is said to be a very hard wood with a specific gravity of 0.94 and of the structure of lancewood. Further investigation will probably show that these woods do not belong to *Anona*.

Common names of the various American species: Pond apple, custard apple, sugar apple, monkey apple, alligator apple, water apple, bullock's heart, sweetsop, soursop (Fla., B. W. I.); anón, anonde escamas, cayul, cayur, cayures, cherimolia, chirimoya, corazón, corazón cimarrón, corcho, guanábana, guanábana cimarrón (P. R.); guanábana, bagá, palo bobo, laurel de cuabal, mamon (Cuba); anona, pomme cannelle, cachiman, coeur de boeuf, corazón, corosol (Trin.); manirito, manirote (Venez.); corossol, corossol des chiens, corossolier, cachiman, pomme cannelle, pomme de cannelle (Guad., Mart.); kamellappel, zuurzak, boschzuurzak, bousi soursakka (Sur.); ata, ate, atte, attier, atocire, cachimentier, hattier, pommier-cannelle (Fr. G.); araticú, araticú alvadio, araticú apé, araticú d'agua, araticú de espino, araticú do brejo, araticú do matto, araticú do mangue, araticú grande, araticú panan, araticú pedra, araticú ponhê, páo de Guine, coracão de boi, caa-apoam, apé, atta, pinha, fruta de conde, imbira, pindaúba, moroló, agouty-treva, maca do cobra, cortica, corticeira, guanábano, restinga, envireira (Braz.); chirimoya, masasamba (Peru); chirimolia (Chile); araticú dulce, arachichú (Arg.);[45] araticú nũ, araticú mí (Par.); cabeza de negra, cabeza de ilama, chincua, ilama, ilana de Tehuantepec, ahate, saramulla, anona (Mex.); soncoya, soncolla, sencuya (C. A.); toreta (Pan.); anona, anona blanca, anona colorada, anona poshte, chirimuyo, guanaba, sincuyo (Salv.).

OXANDRA

The true lancewood of commerce is the product of *Oxandra lanceolata* (Sw.) Baill.,[46] but it is not unlikely that other genera of the Anonaceae contribute to the supply. Lancewood enters the market in the form of straight slender poles with the bark on, under the name of lancewood spars. These are mostly about 13 feet long and rarely over five inches in diameter at the small end and have very little taper. The trees, though usually short and forming a portion of the undergrowth of the forest, attain diameters sometimes as great as two feet, though rarely more than 12 to 15 inches. One reason why only the smaller sizes reach the market is due to the difficulty of transporting the logs from the interior of the rough mountainous country, where they are found, to the place of shipment. It is a common practice in Jamaica for the natives

[45] These Argentine names and many of the Brazilian names are also applied to species of *Rollinia*. In Brazil the name pindaúba (pindaúva, pindahyba, or pindahyva) is also given to *Xylopia* spp.

[46] *Oxandra lanceolata* Baill. = *Uvaria lanceolata* Sw. = *Uvaria virgata* Sw. = *Guatteria virgata* Dunal. = *Oxandra virgata* A. Rich = *Bocagea virgata* B. & H.

to carry out the spars on their shoulders, sometimes requiring two days or more to complete a trip to the village and back. Another reason is that only sapwood is useful and old trees produce heartwood of a black or dark brownish or greenish color resembling ebony and persimmon (*Diospyros*).[47]

The West Indian lancewood is usually preferred by the trade, though the so-called white lancewood is not considered as good as the black kind, the names referring to the trees and not to the woods. This also applies to British Guiana, where the black or swamp lancewood or "karaseri" is said to be of higher quality than the "yarri-yarri" or "arara" of the hills.

Lancewood is little used in this country, much less so than formerly, and much of the wood entering New York is transshipped to Europe. It has the strength and resilience of hickory and is well suited for spokes, shafts, side bars, and other exacting portions of vehicles. Its principal uses at present are fishing rods, whip handles, billiard cues, handles for chisels and other tools, archery bows, and turnery. The natives use it for bows, lances, implements, spars, and beams.

THE WOOD

Oxandra lanceolata (Sw.) Baill. *Lancewood.*

Common names (of this and related woods): Lancewood (Eng. gen.); lanzenholz (Germ.); bois de lance, bois d'arc (Fr.); palo de lanza (Sp.); yaya (Sp. Am.); yaya comun (Cuba); black lancewood, white lancewood (Jam.); haya prieta, haya blanca, yaya, yaya blanca, purio (P. R.); beriba, jejerecou (Fr. G.); yari-yari, yarri-yarri, arara, carisiri, carra-seri, kada-burichi, karaseri, howadanni, arrewawa ? (B. G.); guanabanillo (Venez.); yaya, yalla (Pan.); biribá, embyú branco, pinhão, envira, ouregou, pinda-hyba (Braz.).

General properties: Color of sapwood clear lemon to yellow, suggesting boxwood. Heartwood doubtful; probably small and dark or nearly black.

Odor and taste absent or indistinct.

Hard, heavy, compact. Sp. gr. nearly 1.00. Weight about 62 lbs. per cu. ft. Grain straight. Texture fine, wood fairly easy to work, splits readily, takes a high polish, is very strong; not durable.

Growth rings: Present or absent; usually poorly defined and due to slight differences in abundance of pores and spacing of parenchyma lines.

Parenchyma: In very numerous, very fine, closely and uniformly spaced, concentric lines interrupted by the rays and giving a ladder-like appearance under lens; very much finer than rays; finer than in available specimens of *Anona, Duguetia* and *Rollinia.*

[47] The woods of the Anonaceae have other features in common with the Ebenaceae; for example, the arrangement of the wood parenchyma in fine concentric lines.

Pores: Very small to minute; not distinct without lens; fairly numerous; well distributed; occurring singly or in small groups; smaller than in available specimens of *Anona, Duguetia, Rollinia, Unonopsis,* and *Xylopia.*

Vessel lines: Fine and indistinct.

Vessel contents: Inconspicuous gum deposits present. Calcium carbonate fairly common; abundant in specimens of *Guatteria boyacana* MacBride (Yale No. 416).

Rays: Distinct on cross section; indistinct to invisible on tangential; rather high and very distinct in proper light on radial, though of about the same color as the background; finer than in available specimens of *Anona, Duguetia, Rollinia,* and *Unonopsis.*

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; intervascular pits extremely small, with circular border and narrow mouth. Rays up to six cells wide and 100 cells high; heterogeneous; in contact with vessels the pits are elongated vertically, horizontally or diagonally to include several normal-sized vascular pits; wood parenchyma in laminae, often several cells thick. No oil cells observed. Wood fibers with minute indistinctly bordered pits.

Remarks: The bark, which is usually present on timber in the market, is smooth, finely laminated, and shows distinct wedge-shaped rays.

The true lancewood is very similar to the wood (Yale No. 416) from the type tree of *G. boyacana* MacBride, the "solera" of Colombia. It differs from the wood (Yale No. 406) from the type tree of *Duguetia vallicola* MacBride, the "yaya pino" of Colombia, in texture and also in the fact that its rays are decidedly heterogeneous and without large thin-walled oil or resin cells, while in the latter the rays are homogeneous except for occasional very large thin-walled sac-like oil or resin cells which may also occur in association with the wood parenchyma, a feature which has been noted so far in only one other genus, namely, *Canangium.*[48] The "yaya" of Panama, said to be *Guatteria Schomburgkiana* Mart., yields a hard, heavy, strong wood of a light yellow color that, judging from the specimen available (Yale No. 4325), bears a remarkably close resemblance to the West Indian lancewood. It is considerably harder and finer-textured and has fewer pores than the sample (Yale No. 2997) of *Unonopsis panamensis* Saf. (= *Unona panamensis* Rob.).

Material: Yale Nos. 4460, 4878, 4938 (Cuba); the last with fertile herbarium material collected by Mr. G. C. Bucher, Santiago, Cuba.

17. MYRISTICACEAE

The Nutmeg Family, according to the original classification, consisted of the single genus *Myristica* with several sub-genera. Some botanists now recognize several distinct genera, and limit *Myristica* to Asiatic countries. *M. fragrans* Houtt., native of the Moluccas and

[48] See Moll and Janssonius: *Mikrographie des holzes der auf Java vorkommenden baumarten,* Band I (1906), pp. 111, 125-126.

widely extended by cultivation, yields a fruit, the hard ruminated albumen of which supplies the nutmegs, and the aril or covering, the mace of commerce. All of the representatives of this family have resinous nutmeg-like fruits, but most of them are deficient in aromatic properties.

The woods of the family range from very light and soft to moderately heavy and hard. They are usually light-colored when freshly cut, but tend to darken, some of them becoming deep reddish-brown with darker streaks; they are not highly lustrous. The pores vary from very small to rather large, are few and scattered, occurring singly or subdivided radially two to three times. The vessel perforations are scalariform with rather few heavy bars, or sometimes, with simple perforations also present and, in the larger-pored woods, predominating. Pits between adjacent vessels show a tendency sometimes to scalariform. The rays are very fine, being barely visible on cross and tangential sections, but distinct on the radial, and are decidedly heterogeneous and often very coarse-celled. The pits between parenchyma cells and vessels are large, vary from simple to half-bordered, and look like wide gashes. Wood parenchyma is little in evidence, in some instances occurring only about the pores, in others forming concentric lines apparently limiting growth rings. The fibers have simple or indistinctly bordered pits and often are septate.

There are at least three arborescent genera in tropical America, namely *Virola, Compsoneura,* and *Iryanthera,* but the latter two apparently contain only small or medium-sized trees with light and soft wood of no special importance.

VIROLA (MYRISTICA)

There are numerous species of this genus in Central America and tropical South America, but the available information about most of them is very limited. The "bogamani" of Panama, *Virola Warburgii* Pittier, is a tree 50 to 100 feet high with a straight trunk 10 to 24 inches through, growing gregariously in low fertile lands, particularly river flats, of Panama, where in some parts it forms a conspicuous part of the forest. The seeds are highly resinous and burn with a luminous steady flame and the Indians fasten them on the end of sticks for torches. The wood (Yale No. 3017; Pittier's No. 3505, of type tree) is very pale brown, of light weight, but firm, somewhat coarse-textured, straight-grained, fissile, easy to work, and not durable. Parenchyma is sparingly developed, does not form lines, and is not visible with a lens. The pores are readily visible and are mostly simple; sometimes scalariform with a few heavy bars. The wood is little used, but is suitable for

general carpentry, construction, boxes, and other purposes of general utility requiring a plain, easily worked material and not exposed to decay. It could also be used for paper pulp; the fibers are about 1.3 mm. long.

The wood of the foregoing is almost identical with that of *V. merendonia* Pittier (Yale No. 3679) from the Guatemala-Honduras region, where the tree reaches a height of 110 feet with a symmetrical trunk 30 inches in diameter. The local name is "sangre," referring to the red sap and the reddish blotches which soon appear on the freshly cut wood. The tree supplies some lumber for local uses, but is of limited utility because of its lack of durability.

The "otoba" of Colombia, *Myristica Otoba* H. & B., is a tall tree of chief interest because of the fat obtained by boiling and pressing its nutmeg-like seeds. Dawe[49] says: "The fat is sold in the local markets at about forty cents per pound. The trees are said to give two crops of seeds a year, and from one crop of a mature healthy tree about fifteen pounds of fat can be extracted; small trees yield very much less. This product is very widely applied in this country as a domestic remedy for cattle parasites." The timber is rather soft and is used principally for ceiling boards.

The "dalli" of British Guiana, probably *V. surinamensis* Warb., has a wood that is nearly white when first cut, but becomes reddish and then suggests Spanish cedar (*Cedrela*) in color and consistency.[50] According to Hohenkerk,[51] it is difficult to surface because it is extremely fissile in a radial direction; even when the surface is not parallel to the rays, strips of wood rip out, exposing the silver grain in a most unusual manner. There are apparently two kinds of dalli trees, for although they are similar in external appearance, one is a so-called sapwood tree and the other has a red-brown heart and a distinct light-colored sapwood.

The same species or possibly *V. sebifera* Aubl. is a common tree in the forests in French Guiana, where it is usually known as "yayamadou"; also as "guinguamadou," "Saint-Jean rouge," "ouarouchi," "guiaguia," and "muscadier à suif." According to Bertin[52] it attains a height of 90 to 100 feet, with a clear length upward of 75 feet and a maximum diameter of four feet. The wood has a specific gravity of 0.60, is of a light reddish color, fibrous, coarse-textured, fissile, easily worked, and

[49] Dawe, M. T.: *Account of a journey through the western portion of Colombia,* Col. Bu. Inf. and Trade Propaganda, London, 1919, p. 4.

[50] This species or one closely related to it is sometimes known as white or soft cedar in Trinidad. The native names are "acajou marron," "cayuca," and "anakin."

[51] Hohenkerk, L. S.: A list of British Guiana woods, *Timehri,* 4: 255, June, 1917.

[52] Bertin, A.: Les bois de la Guyane française et du Brésil, *Miss. Forest. Col.,* 5: 145-146 (1920).

not durable. It is used locally for general carpentry and is recommended for boxes, interior construction, and ply-wood.

Two species of common occurrence in the Amazon region are *V. surinamensis* Warb., the "ucuúba branca," and *V. sebifera* Aubl., the "ucuúba vermelha." According to Huber[53] the former especially is one of the most useful woods of that region, not only because of its moderately hard, readily worked wood, but also because the seeds yield a valuable vegetable wax or tallow, useful in making candles and soap.

There are other Brazilian species of general distribution and commonly known as "bicuiba" (variously spelled). The best known species is *Virola Bicuhyba* Warb. (= *Myristica Bicuhyba* Schott.). The trees are fairly common and sometimes reach a height of 90 feet and a diameter of two to three feet. Different qualities of wood are recognized, though it is uncertain whether such variations are to be attributed to a difference in species or to conditions of growth. The better grades are highly esteemed for carpentry, joinery, general construction, and certain kinds of furniture. Owing to the straightness of grain and ease of splitting, the farmers use the timber for pickets and other forms of rived material. The wood of the better class appears to be well suited for many of the purposes for which we use birch (*Betula*) and yellow poplar (*Liriodendron*).

THE WOOD

Virola Bicuhyba Warb. *Bicuiba.*

Common names: Bicuiba, bicuhyba, becuiba, b. branca, b. assú, b. mirim, b. vermelha, arvore do sebo (Braz.). Other species: Ucuúba branca, ucuúba vermelha, ucuiba (Braz.); arbre à suif, baboen, baboenhoedoe, baboenhout, baboentrie, baboun houdou, babun hudu, bali, dalli, dari, dayapa, guiaguia, guinguamadou, g. del monte, jea, jeamadou, mouchigo, m. rouge, moussigo, muscadier à suif, ouarouchi, Saint-Jean rouge, virola, voirouchi, yayamadou (Guianas); acajou marron, anakin, cayuca (Trin.); otoba (Col.); bogamani (Pan.); sangre (Guat.-Hond.).

General properties: Pale brown when fresh, becoming deep reddish-brown with purplish tinge; may be striped; somewhat lustrous. Sapwood of oatmeal color; sharply defined; rather thick.

Odor and taste absent or not distinctive.

Moderately hard and heavy. Sp. gr. (air-dry) 0.63 to 0.72. Weight 39 to 45 lbs. per cu. ft. Grain straight. Texture medium. Wood easy to work, splits easily, takes a smooth finish, holds its shape, looks fairly durable. Appears to be an excellent wood.

Growth rings: Present, but not always clearly defined; due to slight differences in density.

Parenchyma: Not visible with lens.

[53] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:173 (1909).

Photo by H. C. Kluge.

Dalli Forest in Surinam.

(*Virola surinamensis.*)

Embuia and Paraná Pine, Brazil.

(*Nectandra and Araucaria.*)

PLATE XXIV

Pores: Small but visible; rather few; scattered; very commonly in radial groups of two each; open.

Vessel lines: Fine, long scratches; distinct, but not conspicuous.

Vessel contents: Some gum deposits.

Rays: Very fine; faintly visible on cross and tangential sections; distinct on radial surface, producing silver grain about as distinct as in maple (*Acer*); heterogeneous; cells coarse and readily visible under lens on any section.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: This wood is harder and more deeply colored than others mentioned; also exhibits sharp contrast between sapwood and heartwood. Specimen No. 4025 is coarser-textured than others, has few concentric lines of parenchyma and contains white substances in some of ray cells and vessels; may not be this species. The wood of *Compsoneura Sprucei* (A. DC.) Warb. is pale brown, without odor or taste, light in weight, but firm, straight-grained, medium-textured, easy to work and to split, and evidently not durable. The pores are small and barely visible, mostly in scattered groups of two or three. Concentric lines or narrow bands of parenchyma apparently limit growth rings, though occasionally two or three may be close together. The rays are faintly visible on cross section, invisible on tangential, distinct, but not conspicuous, on radial, mostly biseriate in median portion and 25 to 40 cells high; the cells are coarse enough to be seen with hand lens on all sections. The local name of the tree is "sangre."

Material: Yale Nos. 3198, 3256*, 3948*, 4025, 4708* (Braz.); 3683* (Guat.-Hond.). Asterisk indicates botanical material.

18. MONIMIACEAE

This family consists of over 30 genera and about 350 species of aromatic shrubs and trees, confined chiefly to tropical and sub-tropical regions of the southern hemisphere. The leaves are simple, mostly opposite, and without stipules; the flowers are small and borne in cymes. The family supplies few products of commercial importance.

There are at least five arborescent genera in South America, namely, *Peumus*, *Mollinedia*, *Hennecartia*, *Laurelia*, and *Siparuna*. The only one supplying commercial timber is the Chilean "laurel" or "huahuan," *Laurelia aromatica* Juss. There are over 100 species of *Siparuna* in South America and Central America, but they are shrubs and low trees, apparently known only on account of the reputed medicinal value of their leaves. The common names are: Limoeira brava, cidreira do matto (Braz.); limón cimarrón, limoncillo, romadizo (Col.); cerbatana (Guat.); limoncillo, hierba de la conchuda, hierba del talaje (Mex.).

Mollinedia includes about 75 species of trees and shrubs, of which a few belong to Australia, the others ranging from Mexico to southern

Brazil. *M. Schottiana* DC., the "capixim" of eastern Brazil, supplies a tough and elastic wood used for barrel hoops and sieve rims.

Peumus Boldus Mol. (= *Ruizia fragrans* Pav. = *Boldea fragrans* C. Gay), the only species of this genus, is an aromatic evergreen tree 40 to 60 feet high, growing on the dry sunny hills in Chile, where it is known as the "boldo" or "boldu."

The important microscopic features of the woods of the family are as follows: The vessels are small, have a tendency to the formation of scalariform bordered pits, and the perforations are mostly scalariform with many bars; in *Peumus Boldus* Mol., the perforations are mostly simple and the vessel walls are marked with fine spirals. The rays are narrow and the pits into the vessels are large, elliptical, simple to half-bordered. Parenchyma is sparingly developed. The pits in the wood fibers are simple in some genera, *e.g.*, *Daphnandra, Hedycarya, Monimia,* and *Peumus;* indistinctly bordered in a few, *e.g.*, *Mollinedia;* and distinctly bordered in others, *e.g.*, *Doryphora* and *Laurelia.*

19. LAURACEAE

The Laurel Family consists of about 40 genera and 1000 species of aromatic trees and shrubs, widely distributed throughout the tropical and sub-tropical regions of the world, with a few representatives in the temperate zone. Many of them are very large and important timber trees. To this family belongs our common sassafras, *Sassafras officinale* Nees & Eber., the wood of which is distinguished from all other known species by being distinctly ring-porous.

Many of the members of this family are rich in aromatic substances and are the source of such well-known products as camphor, cinnamon, and cloves. The common European laurel, *Laurus nobilis* L., is planted in many countries as a shade tree; the alligator pear or "avocado," *Persea americana* Mill., is a tropical American fruit tree now very widely cultivated; the "nan-mu" tree, whose scented wood is highly valued in China for coffins, is *Persea Nan-muh* Oliv.; and the stinkwood of South Africa, which yields a valuable timber, is *Ocotea bullata* E. Mey. The best known of the tropical American timbers is the Demerara greenheart, *Nectandra Rodioei* Schomb., so highly valued in naval construction. The "bois de rose" of French Guiana is one of the sources of linaloe oil used in the perfume industry. A great many substances produced by this family are medicinal. The woods exhibit great variation in density and in color, but they possess certain features in common which make the group fairly distinct. Many of them are fragrant and nearly all are lustrous.

There is probably no other important family whose members are as difficult to classify and describe. Many of the species, even of different genera, resemble each other so closely that it is often almost impossible to distinguish them in the forest. Flowers are usually necessary for determination and as they are often unisexual, with the two forms borne on different individuals, the collection of complete botanical material is likely to be very difficult. Accordingly, it has been necessary to treat the woods of this family regionally rather than generically. Several countries in which the trees are known to occur, have been omitted because of lack of reliable information concerning them.

West Indies. There are numerous representatives of this family in the West Indies and a few extend into southern Florida, but their timber is of little economic value.

Of the several species of *Persea* the best known is the "alligator pear," *P. americana* Mill., introduced from Mexico and widely cultivated, and now growing spontaneously throughout the region. This is a beautiful tree, 30 to 40 feet high with a trunk 12 to 18 inches in diameter. The wood is light reddish-brown, fine-textured, easy to work, and weighs about 40 pounds per cubic foot. The pulp of the pear-shaped fruit is highly esteemed for eating, and also yields a commercial oil. A reddish-brown indelible dye obtained from the large seeds is used for marking linen, one method being to hold the cloth over the fresh stone and pricking through into the seed with a needle. The common names are: Alligator pear, avocado pear, butter pear, zaboca (Eng.); aguacate, avocate, avocado (Span.); avocatier (Fr.). Other species: Red bay (Bah.); wild pear (Jam.); canela (P. R.); boix doux, doux zabel (Guad.).

There are at least four species of *Phoebe* in the West Indies, but they are mostly small trees. The wood is light brown, hard and heavy, often cross-grained, fine-textured, capable of a good polish. The common names are: Avispillo, laurel, laurel bobo, laurel geo-geo (P. R.); boniatillo, boniato blanco (Cuba); doux cypre (Guad.).

There are numerous species of *Ocotea* and *Nectandra* in this region and some of them attain rather large size and produce timber of good quality, though in limited amount. The wood varies from pale yellow to reddish-yellow and brown, and from moderately light and soft to hard and heavy. It is used locally for general construction and carpentry and to a less extent for cooperage and rived shingles. The common names are: Bastard torch, black torch, sweet torchwood (Bah.); black candlewood, cap-berry, whitewood, lignum dorum, spicewood, shingle-wood, sweetwood (black, white, loblolly, cap-berry, timber, long-leaved, small-leaved) (Jam.); canela, canelon, cacaillo, laurel (bobo, geo, geo-geo,

avispillo, canelon, macho, roseta, sassafras), nemoca, nuez moscada (cimarróna, del pays), sassafras (P. R.); boniato amarillo, boniato cigua, boniato laurel, canelillo, cigua, sigua (Cuba); angelique, boix doux noir, bois d'eau de la Guadeloupe, bois jaune, cêdre cannelle, cêdre gris, cêdre noir, laurier blanc, laurier cannelle, laurier bord de mer, laurier marbre, laurier montagne, laurier rose (Guad., Mart.).

Beilschmiedia pendula B. & H. f. (= *Hufelandia pendula* Nees) is a tree 50 to 60 feet high and 12 to 18 inches in diameter. The wood is of a yellowish-brown color, darkening upon exposure, moderately hard and heavy, straight-grained, fine-textured, strong and durable. It is used for general construction and carpentry. The common names are: Slog-wood, slug-wood, laurier madame (Jam.); aguacate cimarrón, cedron macho, laurel, palo colorado (P. R.); bois negresse (Guad.).

The species of *Acrodiclidium* are small or medium-sized trees with a hard and heavy, greenish-yellow wood of good quality, but of little economic importance because of its scarcity. The common names are: Sweet wood (Jam.); canela, canelillo (P. R.); lebisa, lebrisa, leviza, laurel blanco (Cuba); rose femelle (Guad.).

Mexico and Central America. There are several species of *Litsea* in Mexico, where they are commonly called "laurel." They are small trees or shrubs without value except for the leaves, which are often used as a substitute for tea for beverage purposes. *Sassifridium* is a small Mexican tree known as "laurel," "laurel blanco," "laurelón," and "aguacatillo." Still another "laurel" is *Misanteca capitata* C. & S., a large tree of Oaxaca and Vera Cruz said to supply timber valuable for carpentry and cabinet work. It is also called "palo misanteco" and "laurel de la sierra." There are said to be at least nine species of *Nectandra* in Mexico, but they are mostly shrubs or small trees, only one or two attaining large size. The common names are "aguacatillo" and "piesito de paloma."

The avocado, *Persea americana* Mill. (= *P. gratissima* Gaertn. f.), so widely cultivated throughout the tropics, is probably native in southern Mexico and parts of Central America. It is one of the best known trees of the region and has been cultivated for centuries on account of its fruit, to which many names are given, the most common being "aguacate" or "ahuacate." Another species of *Persea*, known as "laurel" in Jalisco and as "laurel de la sierra" in Sonora, is a small tree with spicy, resinous leaves used in seasoning food.

According to Wercklé,[54] the representatives of this family are very numerous in the temperate region in the mountains of Costa Rica,

[54] Wercklé, Carlos: *La subregion fitogeografica costarricense*, San José, C. R. 1909, p. 37.

where species of *Ocotea, Nectandra, Phoebe,* and *Persea* are large evergreen trees yielding good wood. *Persea frigida* Lind. (= *P. Pittieri* Mez) is a very large tree of the elevated regions, yielding a highly esteemed fruit.

Ocotea veraguensis Mez is a medium-sized tree growing along the Pacific coast of Central America from the Canal to Tehuantepec, and is known on the Atlantic watershed only in Alta Verapaz, Guatemala. It grows as scattered individuals in the forest where it has a long clean bole and scant crown, and is also found in the savannas and pastures where it is of short bushy growth. The bark is smooth and has a distinct cinnamon-like odor. The heartwood, which is very dark brown or nearly black, resembling black walnut (*Juglans nigra* L.), has a pronounced spicy-resinous odor and taste, is moderately hard and heavy, cross-grained, of medium texture, works readily, and is durable. It is used to some extent for light carpentry work, but the supply is small. The common names are: Sigua canelo (Pan.); canelo, canelillo (C. R.); palo colorado (Nic.); pu-bu-buk (Ketchi Indians, Guat.); pimento (Salv.). *Material:* Yale No. 2973 (Pittier's No. 5278).

Phoebe ambigens Blake[55] was collected by Whitford and Stadtmiller in clay soil at Rodezno, Department of Copán, Honduras, at an elevation of about 400 feet. It is a tree about 100 feet high and three feet in diameter, with a scaly gray bark. The wood is sawed into planks and used locally for flooring. It is described below because it is one of the few authentic specimens available.

THE WOOD

Phoebe ambigens Blake — *Guambo.*

Common names: Guambo (Hond.); aguacatillo (Guat.).

General properties: Color dark yellowish-brown; lustrous. Sapwood yellow or grayish-yellow.

Odor and taste not distinctive (in dry specimens, at least).

Rather light to moderately heavy. Sp. gr. (air-dry), 0.50. Weight about 61 lbs. per cu. ft. Grain somewhat roey. Texture rather coarse. Wood easy to work, saws rather woolly, but finishes smoothly, seems to hold its shape well, and looks fairly durable.

Growth rings: Poorly defined, sometimes fairly distinct due to slightly deeper color of late wood; fine light-colored lines visible under lens sometimes separate rings.

Parenchyma: Sparingly developed about pores; the light-colored terminal lines which look like parenchyma under lens are apparently due to other causes.

[55] Cont. Nat. Herb., 24: 1: 3 (1922).

Pores: Fairly numerous, but not crowded; visible without lens; fairly well distributed; occurring singly or more often in radial groups of two or three; open.

Vessel lines: Rather coarse; fairly distinct.

Vessel contents: None observed.

Rays: Fairly distinct on cross section; faintly visible on tangential; producing a fine silver grain on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; bordered pits rather large. Rays nearly homogeneous; two or three cells wide, mostly 15 to 25 cells high; pits into vessels mostly very large and simple. Fibers in fairly definite radial arrangement; peripheral rows flattened radially; walls moderately thick; pits simple; gummy contents common.

Remarks: The wood of *Phoebe effusa* Meissn. of Panama (Yale No. 2972*), which is said to be a tree often 100 feet high and 30 to 40 inches in diameter, is of somewhat finer texture and of a more reddish color. It is known as "sigua blanca" and is extensively used locally for building purposes.

Material: Yale Nos. 3674*, 3697* (Guat.-Hond.). Asterisk indicates botanical material.

Argentina. There are numerous representatives of the Lauraceae in Argentina, ranging in size from little larger than shrubs to giants of the forest, whose trunks are used for making big cargo-carrying dugout canoes. Much confusion still exists regarding the identity of the various species, most of which are usually referred to the two genera *Ocotea* and *Phoebe,* and bear the usual Spanish name "laurel." The woods vary from dingy yellow to nearly black, and from light, soft, and weak to hard, heavy, and strong. Some are not scented, others are spicy, and at least one kind is said to have a disagreeable odor when fresh. Many of the woods are of rather inferior quality and are used for rough construction, fuel, and miscellaneous purposes not highly exacting in their requirements.

A few of the laurels, however, produce excellent timber, the best of which is known locally as "laurel negro," "laurel de la falda," or "ayuí-hú," *Phoebe porphyria* (Gris.) Mez. According to Castro,[56] this is a beautiful tree, 50 to 80 feet high and from 18 inches to four feet in diameter, with a black, shallow-fissured bark, and lustrous evergreen foliage. The heartwood, which is dark and variegated, resembles walnut (*Juglans*), but is richer in color and is highly fragrant. The specific gravity varies from 0.50 to 0.80. The wood is fine-textured, easy to work, takes a glossy polish, holds its place well, but is likely to check

[56] Castro, Eduardo B.: *Las maderas Argentinas.* Rosario, 1918, pp. 170-172.

in the sun, and is highly resistant to decay, insect attack, and marine borers, presumably on account of the gum or resin it contains. It is considered in the same class as walnut and is used for all kinds of civil and naval construction, carpentry, cabinetwork, furniture, and turnery. The curly-grained wood is known as "laurel crespo" (curly laurel). A dye of a deep violet color can be obtained from the sawdust, and the bark is used in the manufacture of fine leather. The "laurel amarillo," *Ocotea puberula* Nees, is a rather large tree with a yellow, peppery wood, common in the carpenter shops and used for tables, shelving, and all kinds of joinery.

Common names: Ocotea: Laurel, laurel amarillo, laurel blanco, laurel hediondo, laurel mestizo, laurel sayiú, canela-guaicá, guaicá, ayuí-morotí, ayuí-saiyú. *Phoebe:* Laurel, laurel crespo, laurel de la falda, laurel negro, laurel overo, canela preta, ayuí-hú, ayuí-pará, ayuí-pichaí.

Material: Yale Nos. 993*, 1003, 1065*, 1707, 1708* (Arg.). Asterisk indicates botanical material.

Brazil. The family Lauraceae is very abundantly represented throughout Brazil and many species yield excellent timbers of high local esteem that are likely to become of much importance for export. Unfortunately much confusion and uncertainty exist regarding the identity of the various species and while the Yale collections are rich in material of this family, few specimens have been specifically identified. It is accordingly impossible to treat this group in the manner it deserves.

Huber[57] says that there are numerous representatives of the Lauraceae in the Amazon region which furnish valuable timber suitable for many diverse uses. The common generic term for the group is "louro," whereas in southern Brazil the name "louro" is applied to species of *Cordia* (Borraginaceae), while the trees of the Lauraceae are known as "canellas." The family is characterized by lanceolate and often aromatic leaves, small yellow or white flowers with anthers which open by means of little valves, and by aromatic fruits which are frequently surrounded at the base by the enlarged calyx so as to resemble acorns.

The "cravo do matto" or "cravo do maranhão," *Dicypellium caryophyllatum* Nees, is a small tree, better known on account of its bark, which has been substituted for both cinnamon and cloves, than for its wood. The "casca preciosa," *Aniba canelilla* Mez, which also has a highly aromatic bark, is a larger tree with a dark gray and compact heartwood noted for its durability.

Closely related to the "casca preciosa" and perhaps belonging to the

57 Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 174-176 (1909).

same genus, is a medium-sized, highly aromatic tree with scented wood—the "macaca poranga" of Santarem. The "itaúba verdadeira" or "itaúba amarella," *Silvia Ita-uba* Pax, a large tree of the upland forests of the lower Amazon, principally of Santarem and Brazilian Guiana, furnishes in large sizes a greenish-yellow wood that is very sound and strong and highly esteemed in ship construction, especially for the hulls. It is much like the "tapinhoan," *Silvia navalium* Fr. All., of southern Brazil. The "itaúba preta," probably *Oreodaphne* or *Ocotea*, seems to have a greater distribution, and supplies a blackish wood suitable for the same purposes as the "acapú" (*Vouacapoua*).

The "páo de rosa" of the state of Pará was identified by Huber as *Aniba parviflora* Mez, a species previously known only on the lower Madeira River, though he was unable to determine whether it is the same as the "louro rosa." The "páo de rosa" from the lower Amazon has a moderately heavy yellow wood that is easy to work and, especially in the form of sawdust or chips, has a rather pronounced and very agreeable fragrance similar to the essence of rose.

There are a great many woods in the Amazon region which are known by the common generic name of "louro," with the addition of a qualifying specific name such as branco, amarello, vermelho, preto, cachoeira, canella, de cheiro, chumbo, congonha, cravo, cunuarú, do igapó, pederneira, pimenta, rosa, tamanco, tamancão, tachy, etc. Most of these belong to the genera *Nectandra* and *Ocotea*, though few of them have been identified specifically. Huber identified "louro pimenta" as *Ocotea canaliculata* Mez, "louro tamanco" as *Ocotea guyanensis* Aubl., "louro tamancão" as *Ocotea* aff. *acutangula* Mez, and "louro do igapó" as *Nectandra amazonum* Nees, but for the greater portion of the species the work of identification remains to be done.

The commonest and most generally used "louro" seems to be the "vermelho," *Ocotea* sp., which is well suited for lumber and which is a regular part of the stock in trade of the lumber yards along with other kinds. The wood is easily worked and although it is considerably heavier than the cedro (*Cedrela*), which it resembles somewhat, it is used for many of the same purposes as that wood and is much cheaper. The "louro preto" is esteemed in ship construction, particularly for masts.

Mr. Curran furnishes the following memorandum regarding the "canellas" in the coastal rain forests of Brazil: "This group of trees includes a host of species, mostly of *Nectandra* and *Ocotea*, and in the present state of our botanical knowledge of the Brazilian forests it is impossible to specify which ones produce the timbers of commerce. The trees are very common, being most abundant perhaps in the transition zone between the tropical and higher sub-tropical regions. The trees as a rule

occur in mixture with other hardwoods and sometimes comprise 50 per cent of the forest. They are generally of fairly good timber form, with diameters up to three feet or more and attaining heights frequently exceeding 100 feet with clear lengths of 50 feet. The woods produced vary in color from very light to very dark, and in density from very soft to extremely hard. Many of them are highly durable and some are very resistant to insect attack, presumably on account of the presence of some resinous or oily deposits."

In southern Brazil all the trees of this family are known by the common generic name of "canella." Pereira[58] enumerates the following kinds: Canella açafrão or vermelha, amarella, batalha or bastarda, branca, capitão-mór, cedro, imbuia clara, imbuia escura, limão, mandóca, parda, pimenta, prego, preta, puante, ruiva, santa, sassafraz amarella, sassafraz preta, and sebo; also canellinha or canella legitima, canellinha embuia or folha larga, canellinha marçanahyba or tapanhúma, canellinha puante or canellão.

In Pereira's descriptions of 16 kinds of "canella," nine are classed as difficult to cut and seven as easily carved. The range of specific gravity given is from 0.52 to 1.08. The color ranges through all shades of yellow and brown to black, often mingling in the same specimen. The uses, which vary, of course, with the qualities of the several woods, include carpentry, cabinetwork and furniture, mouldings, flooring, boxes, general construction, shipbuilding, bridges, posts, and railway ties. The "canellas" are found in every part of the State of São Paulo, abounding in the cooler regions. The trees vary much in size. Almost all of them are put to some industrial application, the most noteworthy being the "canella parda," *Nectandra amara* Mart., the "canella preta," *Nectandra mollis* Meissn., and the "canella sassafraz," *Ocotea pretiosa* Nees. There are also some woods called "canella" which belong to other families.

A timber now being exported in considerable quantity from southern Brazil is the "embuia," *Nectandra* sp., which grows abundantly in the forests of the Paraná pine (*Araucaria brasiliana*). According to Whitford,[59] these forests contain four well-defined stories, the upper or cap being composed entirely of the pine which is from 80 to 120 feet in height. Just beneath the crowns of the pines are those of another story 60 to 80 feet high, composed mostly of eight or ten species of Lauraceae. One of these, the "embuia," comprises 50 per cent or more of the stand of this story and is about the only hardwood cut in the pine

[58] Pereira, Huascar: *The timber trees of the State of São Paulo, Brazil*, pp. 24-29.

[59] Whitford, H. N.: The structure and use of the Paraná pine forests of Brazil, *Journ. Forestry*, 17: 2: 154-158, Feb., 1919.

region, being considered the timber *de luxe* of southern Brazil, and used for fine furniture, cabinet work, and interior trim, and also for general construction. It is much in demand for railway ties, the average life in that region being between 15 and 20 years. The railways of the States of Paraná and Santa Catharina consume nearly half a million "embuia" ties annually for their maintenance. (Plate XXIV.)

THE WOOD

Nectandra sp. *Embuia.*

Common names: Embuia, embuia amarella, embuia vermelha, embuya, imbuia, canella imbuia (Braz.); Brazilian walnut (U. S. trade).

General properties: Color olive to chocolate-brown, deepening upon exposure; lustrous. Sapwood yellowish or yellowish-brown; line of demarcation not very sharp.

Odor and taste spicy-resinous.

Moderately hard and heavy. Sp. gr. (air-dry), 0.70 to 0.76. Weight 43 to 47 lbs. per cu. ft. Grain fairly straight; sometimes curly. Texture medium to rather fine. Wood strong, easy to work, finishes smoothly, appears durable.

Growth rings: Distinct; due to somewhat denser and darker-colored narrow layer of late wood.

Parenchyma: Sparingly developed about pores; scarcely visible with lens.

Pores: Small, but visible; fairly numerous but not crowded; well distributed; occurring simply or more often in radial groups of two or three.

Vessel lines: Visible as fine dark lines.

Vessel contents: Dark gummy substance very common.

Rays: Very fine; faintly visible on cross section; invisible on tangential; visible, but low and inconspicuous, on the radial, appearing of same color as background.

Ripple marks: Absent.

Gum ducts: None observed.

Material: Yale Nos. 3893, 3894, 3895, 3896, 3292*, 3294*, 3318, 4884 (Braz.). Asterisk indicates botanical material.

The Guianas. The Lauraceae are among the commonest and best known timbers of the Guianas, particularly of British Guiana. The most noted is greenheart, which is confined almost entirely to British Guiana and which has been an important article of the export trade for more than a century. Under the name "silver-balli" is included a miscellaneous group of very light to medium heavy woods belonging to three or more genera in British Guiana. Woods of this class are known as "cèdre" in French Guiana, and "sirvaballi" and "pisie" in Surinam. Perhaps the best known of the trees in French Guiana is the "bois de rose," which yields the fragrant oil of linaloe upon distillation. Accord-

ing to Bertin,[60] one of the most highly esteemed timbers of French Guiana is the "grignon," *Ocotea rubra* Mez, which is believed to be the same as the "determa" of British Guiana and the "wane" of Surinam. Another important wood is the "waibaima," which is as hard and strong as greenheart and sometimes confused with it.

"WAIBAIMA"

"Waibaima," *Nectandra* sp., is a tree about 90 feet high with a straight cylindrical trunk two or three feet in diameter and free of branches throughout most of its length. Logs upward of 40 feet long, squaring 20 to 28 inches, are obtainable, though the supply along the Essequibo and Demerara Rivers is very limited. It is a wood of excellent quality and valued in shipbuilding, particularly for planking vessels. In Surinam, where it is known as "pisie" (hard) or "siroaballi tataroe," it is much used for house construction.

The wood is lustrous reddish-brown, with a thin yellowish sapwood that is sharply defined. The dry wood is without characteristic odor or taste, but the fresh wood is said to be fragrant. It is very hard, heavy, and horn-like; specific gravity is about 1.15; weight about 71 lbs. per cu. ft.; splits easily, takes a beautiful polish, and is highly durable. Growth rings are rather indistinctly defined; parenchyma occurs in small amount about the pores, which are readily visible and scattered irregularly, sometimes in irregular concentric zones. Tyloses are abundant and some of the vessels contain white substance. The rays are fairly distinct without a lens on cross section, faintly visible on the tangential, and producing a fine silver grain on the radial surface, where they appear lighter than the background; they are mostly biseriate, variable in height, and composed of thick-walled cells, the marginal ones being large and upright. *Material:* Yale Nos. 4964*, 5075 (B. G.); 4177 (Sur.).

"DETERMA"

"Determa," *Nectandra* or *Ocotea* sp., is a very important timber tree. It makes its best development along the rivers where the soil is moist and clayey or gravelly, and is found also on the slightly elevated portions of the central region in moist sandy soil. The average height of the trees is about 100 feet, and the timber can be had in logs 30 to 40 feet long, 30 inches square, free of sap. Spars have been obtained that were from 70 to 80 feet long and 14 inches in diameter at the small end. It is used for planking boats, making dugout canoes, and for

[60] Bertin, A.: Les bois de la Guyane française et du Brésil, *Mission Forestiere Coloniale*, vol. 5, Paris, 1920, pp. 111-112, 170.

the construction of railway carriages. It can be used for many other purposes for which a fairly light, though strong, wood is required.

THE WOOD

Nectandra sp. *Determa.*

Common names: Determa, tetruma (B. G.); tétéroma, wane (Sur.); grignon, grignon franc, grignon rouge (Fr. G.); louro rosa ? (Braz.).

General properties: Color uniform pinkish-red with a golden luster in proper light. Sapwood gray, distinct; line of demarcation is not very sharp. Odor and taste absent or not distinctive.

Of medium weight and density. Sp. gr. (air-dry) about 0.70. Weight about 43 lbs. per cu. ft. Grain straight to irregular. Texture coarse. Strong, but rather brittle, fairly easy to work, finishes rather smoothly, appears fairly durable.

Growth rings: Absent or poorly defined.

Parenchyma: In narrow circles about pores and joining them into irregular diagonal lines; distinct without lens.

Pores: Rather large and distinct; numerous, but not crowded; occurring singly or as though subdivided radially; irregular diagonal arrangement due mainly to parenchyma; closed.

Vessel lines: Rather coarse; distinct, but not conspicuous.

Vessel contents: Tyloses abundant.

Rays: Fine, but fairly distinct, on cross section; faintly visible on the tangential; very distinct on radial surface, producing a fine silver grain.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; bordered pits large. Rays mostly biseriate and up to 30 cells high; cells coarse, often short, the marginal ones larger and sometimes upright; gummy; pits in vessels very large, simple to half-bordered.

Remarks: Distinct from other members of this family, especially in color and in arrangement of pores; also lacks the silky sheen characteristic of so many of them. In texture and consistency is much like *Carapa*.

Material: Yale Nos. 3037, 5079 (B. G.); 4165, 4023A (Sur.); 5382 (Fr. G.); 3923 (Amazon region, Brazil).

"SILVER-BALLI"

"Silver-balli" is a corruption of the Indian name "cirou-balli" or "sirua-balli." Several different kinds of "silver-balli" are distinguished according to the deeper or lighter shades of brown and yellow. They belong to the genera *Nectandra*, *Ocotea*, and *Aniba*.

Brown "silver-balli" often attains a height of 90 feet and furnishes logs 30 feet long and 26 inches square. The heartwood of this tree has the general appearance of greenheart, but is not so hard and heavy,

weighing only about 43 pounds per cubic foot. It is used chiefly for boat- and house-building.

"Keriti silver-balli" or "kretty" is very abundant in some localities in the central part of British Guiana. The average height of the tree is about 80 feet, and logs 30 feet long and 20 inches square can be readily obtained. The wood is pale brown with a satiny luster; has an aromatic odor; is light (about 28 pounds per cubic foot), but rather strong and tough considering its weight; and not very durable. It is well suited for partitions in houses and for the upper planking of boats.

Yellow "silver-balli" of British Guiana, or the soft "pisie" or "pisi"[61] of Surinam, is a tree often ranging from 50 to 70 feet in height and from one to two feet in diameter. The wood is of a lustrous golden yellow color, is aromatically scented; weighs about 35 pounds per cubic foot, and is strong, tough, and very durable. It is used principally for planking boats, but it can be used successfully for a good many other purposes.

Material: Yale Nos. 3027, 3029, 3030, 3030A, 3051, 3052, 4217, 4226, 4227, 5075, 5076, 5077 (B. G.); 4178, 4189 (Sur.).

GREENHEART

The greenheart, *Nectandra Rodioei* Schomb. (= *Ocotea Rodiei* Mez), is a large evergreen tree, ranging from 70 to 120 feet in height and from two to three feet in diameter, though these dimensions may occasionally be surpassed. The trunk is straight, cylindrical, and, unlike that of many of its associates, is not buttressed. The trees are usually without branches for the first 50 to 70 feet and logs or timbers from 15 to 20 inches square, free of sap, can be obtained. The bark of the trunk and larger branches is thin, flinty-brittle, smooth or somewhat scaly, and of a grayish-white color that is very distinctive. The young branches are covered with a very fine light-brown tomentum. The main trunk of a mature tree whose top extends above those of its neighbors, subdivides into a conspicuously open, irregular and large-branched crown. A young tree in the dense forest has a spire-like or cone-shaped crown similar to those of the trees with which it associates.

New leaves are produced on the ultimate twigs during the summer, and the old leaves on the branches, which are from two to three years old, are gradually shed throughout the year. They are arranged alternately

[61] For detailed description of the minute anatomy of "pisi," see Janssonius, H. H.: Mikrographie einiger technisch wichtigen Holzarten aus Surinam. *Ver. d.k. Akad. v. Wettenschappen te Amsterdam,* 18: 2: 46-50, Feb., 1914.

or in pairs, one nearly opposite another on the twig. The leaf stalks are short and the thick leathery leaf blades, which are pointed at both ends, are from four to seven inches long and from one to two inches wide. The small and rather inconspicuous flowers are of a yellowish-white color and have an agreeable fragrance suggesting jasmine.

Greenheart is essentially a British Guiana tree. It does not grow in the West Indian Islands, as is generally believed, but it is confined entirely to restricted areas on the mainland of northern South America. Correa[62] states that greenheart is found in the northern states of Brazil. Miers[63] likewise reports it from the same region and also from the country along the Amazon River. There are, however, no published or other valuable records giving any information relative to the abundance of the trees in Brazil. Correa states that the wood is used in the northern provinces of Brazil for naval construction and for luxurious furniture, from which it may be inferred that the tree must occur in commercial quantities. Although true greenheart doubtless grows in parts of Brazil and in the region of Maroni in French Guiana, no samples of the wood were included among the material from these countries exhibited at the Pan-American Exposition at Buffalo in 1901. It appears probable that greenheart is found in eastern Venezuela, but there is no wood or botanical specimen in any of the large herbaria in this country giving proof that the tree grows there at all. The presence of the true greenheart in Surinam has been positively determined by the forest officers of that country. There are several small stands of it on the Upper Maratakka River, but the total amount of timber so far discovered is too small to be of any special economic importance.

The only region where greenheart is now being exploited is British Guiana. The forestry officer, in his general report on the forests of the easily accessible districts of the Colony for 1912, gives the distribution of greenheart as follows: "The greenheart forest areas are almost entirely confined to the central part of the Colony, which are traversed by the Essequibo, Demerara, and Berbice Rivers and their tributaries. They disappear toward the eastern borders of the Colony, and in the northwestern District there are only a few small areas of this wood in the forests on the Barama River, and further westward only a small patch has so far been found in the forests on the Aruka River."

The valuable properties of greenheart first became known to the English timber merchants in 1769. The trade in this wood gradually developed until it became one of the foremost industries of British

[62] Correa, M. Pio: *Flora do Brazil,* Rio de Janeiro, 1909, p. 21.

[63] Miers, John: *A catalogue of the woods of Brazil.* A manuscript in the Library of the Herbarium of the National Museum, Cromwell Road, London.

Guiana. Most of the timber has gone to Europe, particularly to England, and comparatively little to the United States.

The chief uses of the wood are in the construction of ships and docks, especially for keelsons, beams, engine bearers, planking, dock and lock gates, piers, and piling. All of the gates, piers, and jetties of the Liverpool docks and practically all of the lock gates of the Bridgewater Canal (England) are of greenheart. The Manchester Ship Canal is regulated by 54 pairs of gates composed entirely of this wood. One of the most important recent uses was in the construction of the lock gates and dry docks of the Panama Canal. Greenheart is in extensive use as piling in the British Isles, the Netherlands, France, and, to a smaller degree, Germany, and has been placed in the port works of La Guayra, Venezuela; Rosario and Bahia Blanca, Argentina; and Coalzacoaloos, Mexico. In Demerara the timber is used in the construction of houses, fences, wharves, board walks, and for paving blocks, and is the favorite wood for flooring, shipbuilding, and vehicle manufacture. Other uses include fishing rods, automobile spokes, carriage shafts, various articles of turnery, and charcoal.

Greenheart tends to check and splinter in drying and requires great care in seasoning and in working. The logs often cleave at the ends into four segments, but the cracks usually do not extend deeper than two or three feet. Tests on green material by the U. S. Forest Service[64] showed a moisture content of at least 45 per cent and the shrinkage in volume from the green to oven-dry condition was 13 per cent or about seven-eighths as much as white oak (*Quercus alba*). In the form of a beam or a post, greenheart was found to be 25 per cent stiffer than black locust (*Robinia pseudacacia*), the strongest and stiffest of the 130 species of North American woods tested. In resistance to shock it falls considerably below the hickories and classes with beech, birch, ash, and oak. It is about as hard as dogwood (*Cornus florida*) and black locust, is more difficult to work than oak, planes well, turns hard and badly, polishes indifferently, and takes nails poorly. It is neither more nor less inflammable than any other timber of the same dry weight per cubic foot, but on account of its great density is highly fire resistant. The heartwood proved highly resistant and, in most cases, practically immune to the action of 23 different wood-destroying fungi to which it was subjected in the laboratory, in spite of the fact that the organisms developed luxuriantly in the tubes containing the test specimens. The sapwood proved far less resistant.

Greenheart has so long been considered immune to the attacks of

[64] Armstrong, A. K.: "Greenheart, used in Panama Canal, is a timber of exceptional qualities." *Engineering Record,* Jan. 29 and Feb. 5, 1916.

marine borers that failure from this cause has been considered positive proof of the substitution of spurious material! That this position is untenable is shown by the fact that a sluice gate made of true greenheart from Demerara placed in a lock in the Saramacca Canal in brackish water in 1916 was removed in 1918 because it was completely riddled by shipworms. A specimen of this wood, collected by Dr. Whitford and authenticated by Mr. J. W. Gonggrijp, Forester of Surinam, is now in the Yale collections (No. 4434) and there can be no doubt as to its identity. In February, 1920, another trial was given Demerara greenheart in this lock, but it was likewise attacked and was replaced in May, 1921. A specimen of this wood (No. 4955) has been contributed to the Yale collections by Mr. Gonggrijp and its genuineness is beyond question.

The shipworm causing this damage was sent by Mr. A. Reyne, Entomologist of the Department of Agriculture of Surinam, to the U. S. National Herbarium and has been described by Mr. Paul Bartsch as *Teredo Reynei* of a new sub-genus called *Neoteredo*.[65] The holes made by this borer are much larger than those of the ordinary shipworm. The maximum diameter of the holes in the Yale specimens is about one-half inch, many of them being between one-fourth and two-fifths inch. Holes four-fifths of an inch in diameter were made by this new species in long submerged specimens of "mora" or "peto" wood (*Dimorphandra excelsa* Baill.), according to Reyne.[66]

From the limited information available it appears there exists in the brackish waters near the mouth of the Saramacca Canal in Surinam a form of *Teredo* to which greenheart is not immune. The occurrence of this species elsewhere has not been reported. The resistance of the heartwood of greenheart to the attacks of ordinary forms of shipworms is very high and probably is not exceeded by that of any other wood. This resistance to borers, as well as to decay, has been ascribed to the presence in the wood of certain alkaloids, among which are bebeerine (C_{18} or $_{19}H_{21}O_3N$) and nectandrine ($C_{20}H_{23}O_4N$), but this has not been proven.

THE WOOD

Nectandra Rodioei Schomb. *Greenheart.*

Common names: Greenheart (brown, black, white, yellow, etc.), Demerara greenheart (Eng., gen.); bebeeree, bebeeren, bebeeru, bibir, bibira, bibiri, bibiroo, bibiru, cipiri, sepira, sepeira, sipeiro, sipira, sipiri, supeira, tugui,

[65] Proc. Biol. Soc., Washington, 33: 69-70.

[66] For fuller information see Gonggrijp, J. W.: Over Demerara greenheart, manbarklak en een nieuwe tegen paalworm bestande houtsoort. *West Indië* (an agricultural periodical for Surinam and Caraçao), Sept., 1921.

tugul, wainop, rora-ek (B. G. Indians); greenheart de la Guyane anglaise (Fr. G.); beberuboom, geelhart, groenhartboom, maratakka, pakouli (Sur.); bibiru, itaúba ? (Braz.); viruviru (Venez.); grünherzbaum, grünholz, beberubaum, bibirubaum (Germ.); torchwood, queenwood (Misc.).

General properties: Color light to dark olive or nearly black; often with intermingling of lighter and darker areas; lustrous. Thick sapwood pale yellow, becoming greenish upon exposure; not sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. 1.06 to 1.23. Weight 66 to 77 lbs. per cu. ft. Texture medium. Hard to cut, easy to split, finishes smoothly, is extremely durable. Statements that the wood is poisonous to workmen are apparently untrue.

Growth rings: Absent, or vaguely defined.

Parenchyma: In very narrow circles about the pores; readily visible; not in lines.

Pores: Rather small, but very distinct on account of parenchyma; uniform; mostly oval in shape; numerous, but not crowded; well distributed; occurring singly or sometimes subdivided radially.

Vessel lines: Rather fine; distinct, but not conspicuous, in proper light due to parenchyma; mostly long and straight.

Vessel contents: Some gum deposits in darker portions.

Rays: Invisible or nearly so on cross and tangential sections; fine and inconspicuous, though distinct in proper light, on radial surface where they may appear either lighter or darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Average diameter of pores 0.13 mm. Rays mostly biseriate (occasionally uniseriate), few to 30 or rarely 40 cells high; mostly homogeneous, but sometimes marginal cells are square or upright. Wood fibers small, arranged in radial rows; walls very thick and cavities minute.

Remarks: Greenheart is readily distinguishable from the "silver-ballis" by its greater density; from "determa" by the color and density; and from "waibaima" as follows: In waibaima the color is reddish-brown, the sapwood is thin and distinct, the rays are readily visible without lens, and the pores are comparatively few and scattered.

Material: Yale Nos. 3041, 4218, 4432*, 4433, 4434, 4785, 4955, 5072, 5073, 5074 (B. G.); 4175 (Cur.). Asterisk indicates botanical material.

"BOIS DE ROSE"

The "bois de rose" is one of the best known timbers of French Guiana and for a long time was shipped to France for the manufacture of furniture. In 1875 a Frenchman by the name of Samain succeeded in distilling from it a sweet-smelling oil, and this new use of the wood eventually replaced all others.

This oil first appeared on the export list of Cayenne in 1889 under

the name of "huile de linaloès" or "huile d'aloès" and later as "essence de bois de rose." For a time the wood was shipped to France for distillation, but owing to the loss of oil in transportation it was found best to manufacture the essence in Cayenne. The industry, which is a very important one, is now monopolized by a French concern and nearly all of the product goes to France for use in perfume manufacture.

The trees are felled and cut into convenient lengths as for firewood, the wood of the roots included, and conveyed to the nearest creek where it is shipped in small boats to larger river vessels which take it to Cayenne. Before the war the price of the wood was from 75 to 80 francs per 1000 k.g., but later this was materially increased and in some instances more than doubled. The oil content of the wood is about 18 per cent. The wood is "hogged" or chipped by special machines and the fresh chips are run into retorts having a capacity of 900 to 1000 liters. The usual charge is 90 to 100 k.g. of wood and 100 liters of water and the process of distillation requires about an hour and a half. Steam is admitted into coils at the bottom of the retort at a pressure of three atmospheres and the distillate of oil and water is caught in vessels and separated by gravity, the oil having a specific gravity of from 0.86 to 0.88. The essence must be stored in a cool place in dark, hermetically sealed containers, since upon prolonged exposure to air, light, or heat it loses its clearness and its pleasant scent and becomes yellow, syrupy, and of a turpentine odor.

The identity of the "bois de rose" is still in doubt. It is referred to by various authors as *Licaria guianensis* Aubl., *Ocotea caudata* (Nees) Mez, *Dicypellium caryophyllatum* Nees, and *Acrodiclidium chrysophyllum* Meissn. According to the researches of Gonggrijp,[67] from which much of the information given here is obtained, the "echt rozenhout" of Surinam, which is considered identical with the "bois de rose femelle" of French Guiana, is a species of *Aniba*, nearest to *A. panurensis* Mez. This is in conformity with Huber's statement (*loc. cit.*, p. 175) that the "páo rosa" of the Amazon region is *Aniba parviflora* Mez.

According to Gonggrijp (*loc. cit.*), the tree occurs scatteringly in the mixed hardwood forests, is tall and slender, and comprises a part of the story immediately beneath the dominant trees. The stem is straight and cylindrical and covered with a reddish-brown bark which flakes off in patches. The inner bark, which is about 0.2 inch thick, is very fragrant and is composed of a soft, light brown ground-mass in which there are numerous dark-colored, horny, radially compressed fiber bundles which are crossed by the fine rays (two to six per bundle).

[67] Gonggrijp, J. W.: Rozenhout, bois de rose femelle, uit Suriname, *De Indische Mercuur*, Apr. 23 and 30, 1920.

The outer surface of the sapwood is finely grooved and the light color changes to a rusty brown in patches soon after a fresh blaze is made. The crown of the tree is very small, with a few thick, upright, and quite straight branches. The leaves are from six to eight inches long and two to three inches broad, the upper side dark green, the under side rather golden brown and velvety.

Up to 1920 the wood was only exploited in the eastern part of French Guiana, where the trees occur as scattered individuals in the forest. In 1918 the trees were found along the Gonini and Tapanahoni Rivers in Surinam and are now being exploited there to a limited extent.

THE WOOD

? *Aniba panurensis* Mez — *Bois de Rose.*

Common names: Bois de rose, bois de rose femelle, bois de rose male, bois de rose de Cayenne, linaloé de Cayenne, bois de citron de Cayenne, bois jaune, bois de licari, bois de taxalm, bois de poivre, bois de capahu, bois de licari, likari, sassafras (Fr. G.); rozenhout, echt rozenhout (Sur.); Guiana linaloe wood, Cayenne linaloe wood, Cayenne sassafras (Eng.); rosewood.

General properties: Color lustrous yellow, eventually turning brownish or reddish on the surface. Sapwood oatmeal color; not very clearly defined.

Odor of freshly worked wood very pronounced, suggesting sassafras; taste also pronounced, somewhat like nutmeg.

Moderately hard and heavy. Sp. gr. (air-dry) 0.60 to 0.68. Weight 37 to 43 lbs. per cu. ft. Grain fairly straight. Texture medium. Easy to work, splits readily, finishes smoothly, is firm and strong, durable; feels rather oily.

Growth rings: Present, but not very distinct without lens; due to narrow layer of denser late-wood.

Parenchyma: Sparingly developed about pores; indistinct even with lens.

Pores: Small, but visible; fairly numerous, but not crowded; well distributed; occurring mostly in radial groups of two or three; mostly open.

Vessel lines: Fine and inconspicuous; have a yellow-ochre color.

Vessel contents: Some tyloses present.

Rays: Very fine; faintly visible on cross and tangential sections; uniformly low, but distinct, on radial surface appearing darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: One of the most distinct features of this wood is the presence of very large thin-walled oil cells in the rays and parenchyma strands; appear on cross section as intercellular canals. Rays heterogeneous; mostly biseriate, few to 20, mostly seven to 12, cells high; pits into vessels large and appear like scalariform perforations. Fibers in radial rows; many of them septate; pits simple or indistinctly bordered. Yellow oil present to greater or less extent in all elements.

Material: Yale Nos. 4435 and 4781 (Sur.), supplied by J. W. Gonggrijp.

20. CAPPARIDACEAE

The Caper Family consists of about 35 genera and approximately 500 species of herbs, shrubs, and small trees widely distributed over the warmer parts of the world. A few of the plants are cultivated for decorative purposes, some are credited with medicinal properties, and a few yield woods of some local utility, but the only articles of commerce are the so-called capers, the dried or pickled flower-buds of *Capparis spinosa* L., a shrub of the Mediterranean region and extending into India. There are four tropical American genera which contain small trees, namely, *Crataeva, Capparis, Morisonia,* and *Belencita.*

The woods are of two classes: (1) those of normal structure, including all of the tropical American representatives so far as known; (2) those of anomalous structure, for example, *Niebuhria, Maerua,* and *Cadaba* of India, with alternate layers of wood and bast of the *Avicennia* type.

The light-colored or sometimes brownish woods vary from hard, heavy, fine-textured, and compact to rather soft and light with medium texture; the rays may be very fine or moderately coarse; the pores often show a tendency to radial arrangement; parenchyma is present in varying amount, sometimes indistinct, sometimes in circles about pores, and sometimes also in fine concentric lines limiting growth rings. The vessels have simple perforations, and the vessel-parenchyma pits are half-bordered; the fibers have simple or indistinctly bordered pits; the rays are homogeneous.

CRATAEVA

The best known species of this genus is *Crataeva Tapia* L., which has a wide range of distribution in tropical America. The fruit and, in lesser degree, the fresh wood have a garlic-like odor and in Brazil the tree is on that account sometimes referred to as "páo d'alho"[68] (garlic wood), though it is more commonly known as "tapia." The tree is rarely 50 feet high and 20 inches in diameter, with a white or yellowish wood only moderately hard, of medium texture, fairly easy to work, brittle, and not durable. Growth rings are fairly distinct; parenchyma is in circles about the pores and sometimes uniting them, and sometimes also in concentric lines limiting growth rings. The pores are rather small, distinct because of parenchyma, fairly numerous, occurring singly or in radial groups of two or three. The rays are readily visible on cross and radial sections, but not on the tangential. The wood is little used, but is suitable for paper pulp and minor carpentry purposes. *Material:* Yale Nos.

[68] The common "páo d'alho" is *Gallesia* (Phytolaccaceae).

1061 and 1063 from Argentina, checked by descriptions and photomicrographs of other woods of this genus from Panama, Formosa, and India. The common names are: Tapia, páo d'alho (Braz.); naranjillo, flor de seda, papaguá-naranja, papaguayon (Arg.); toco, tocque, garlic pear (Trin.).

CAPPARIS

There are about 280 species of *Capparis*, mostly tropical shrubs, small trees, and climbers, many of them occurring in very dry regions. At least two of the West Indian species reach the shores of southern Florida, where one of them, *C. jamaicensis* Jacq., develops into a tree 18 to 20 feet high and sometimes five or six inches in diameter, though in the West Indies it sometimes attains a height of 50 feet. Species of *Capparis* are very common in the thorn forest of the arid regions of South America. The wood is mostly hard and compact, fine-textured, and of a whitish or yellowish color. Growth rings are usually distinct; the pores are small and numerous, often in radial rows; parenchyma, which is variable in abundance, is associated with the pores and sometimes in fine concentric lines limiting growth rings, and may be distinct or indistinct; the rays are fine and scarcely visible without lens. About the only known use is for fuel. *Material:* Yale Nos. 2772, 2776, 2797, 2814 from Caraçao. The common names of various American species are: Caper-tree, Florida caper (Fla.); black willow, caper-tree (Bah.); burro, burro blanco, palo de burro prieto (P. R.); carbonero, palo diablo (Cuba); oliva, oliva macha, kade besji (Curaçao); bois d'olive, mabouya, olive wood (Trin.); olivo, ajicito, guariare, juan blanco, paniagua (Venez.); fructeira de burro (Braz.); azucena del monte, amarguillo, sacha membrillo, meloncillo, cayampa, mui-kurékaá, cayampa, yerba de comadreja, azar-rá (Arg.); curumo, guacoco (Salv.).

21. CUNONIACEAE

This family (often included in the Saxifragaceae) consists of about 20 genera and 180 species of trees and shrubs, indigenous chiefly to the temperate and sub-tropical regions of the southern hemisphere; a few species of *Weinmannia* occur in the northern hemisphere.

Macrodendron corcovadensis Taub. is said to be a tall tree with opposite, simple leaves, growing in the Corcovado Mountains of Brazil. There are ten known species of *Belangera* in the woodland islands of the plains of southern Brazil and one in Paraguay. They are small trees with opposite, palmately compound leaves, winged seeds, and an astringent bark rich in tannin. The wood is said to be used to a limited extent for canoes, interior works, and carpentry. The common name in Brazil

is "salgueiro do matto." *Caldcluvia paniculata* Don. is a small tree with slender opposite leaves of a beautiful lustrous green, growing along the coast of southern Chile, where it is known as "tiaca." The wood is used for fuel.

WEINMANNIA

This genus consists of about 130 known species of shrubs and trees of very wide distribution. *Weinmannia lachnocarpa* F. v. M., the "marara" or "mararie" of Australia, is a large tree yielding a hard, fine-textured, pinkish-colored wood that is considered among the best of that country. *W. racemosa* Forst., the "towhai" or "kamahi" of New Zealand, is a very common tree on poor soils, but the wood is not highly esteemed.

W. trichosperma Cav. is a tree sometimes 50 feet high and 18 inches in diameter growing in Patagonia and Chile. It has opposite, imparipinnate leaves with winged petioles. The wood is of excellent quality and is used to a limited extent for furniture and cabinet work.

THE WOOD

Weinmannia trichosperma Cav. *Tenio.*

Common names: Tenio, teneo, tinel (Chile, Pat.). Other species: Bastard braziletto, wild braziletto (Jam.); encina, encinillos (Col.); lorito, madroño (C. R.).

General properties. Color rosy to brownish with darker striping (due to deeper color of late wood), suggesting birch (*Betula lenta* L.); lustrous. Sapwood lighter, not sharply defined.

Odor and taste absent or not distinctive.

Of medium hardness and density. Sp. gr. (air-dry) 0.59. Weight about 37 lbs. per cu. ft. Grain mostly straight. Texture fine and uniform. Easy to work, takes a high polish, holds its place; darker-colored specimens appear rather durable.

Growth rings: Distinct; due to narrow layer of darker color and somewhat less abundant pores; give pleasing figure to tangential surface.

Parenchyma: Sparingly developed; not visible with lens.

Pores: Minute; not visible without lens; abundant; uniformly distributed or sometimes less numerous in late wood; angular in outline.

Vessel lines: Very fine and indistinct.

Vessel contents: Some gum deposits in dark-colored specimens.

Rays: Minute; very numerous; not visible without lens on cross and tangential sections, distinct, but inconspicuous, on the radial, appearing darker than the background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with scalariform perforations, many bars; pits

usually scalariform. Rays heterogeneous, one to three cells wide and few to 30 cells high; gummy; pits into vessels often scalariform, simple to bordered. Wood fibers with distinctly bordered pits. Parenchyma diffuse or in irregular tangential rows in outer portion of growth rings.

Remarks: W. rubifolia (Yale No. 2650) of Australia is much harder, has fewer pores, and the parenchyma is in exceedingly numerous fine tangential lines visible under lens. The minute anatomy is very similar.

Material: Yale Nos. 1759 (Patagonia); 3757 (Reserva Forestal Malleco, Chile).

22. HAMAMELIDACEAE

The Witch Hazel Family consists of 20 genera and about 50 species confined to eastern North America, southwestern, southern, and eastern Asia, the Malay Archipelago, Madagascar, and South Africa. Three genera are represented in North America, two of them, *Hamamelis* and *Liquidambar*, being arborescent. The common witch hazel, *Hamamelis virginiana* L., is one of the best known shrubs or small trees in eastern United States, and is used commercially as a source of witch hazel extract.

The red gum, *Liquidambar styraciflua* L., is a large and important timber tree, most abundant in the southeastern United States, but with a range extending from Connecticut southward and westward to Texas, reappearing on the mountains of central and southern Mexico and the highlands of Guatemala, Honduras, and Nicaragua. A resin or balsam, excreted from wounds in the bark, is collected in considerable quantities in Mexico and Central America and has been much used for medicinal purposes from the earliest times. The wood is of much the same quality throughout the range of the tree and the uses of the American timber for construction, furniture, veneers, etc., are too well known to be enumerated in detail. The timber growing in Mexico and Central America has not yet come into general use.

THE WOOD

Liquidambar styraciflua L. *Liquidambar.*

Common names: Red gum, sweet gum, gum-wood, liquidambar, bilsted, hazelwood, alligator wood, ambar wood (U. S.); hazel pine, satin walnut (Eu. trade); amberholz, satinnuss-baum (Germ.); legno di noce satinato (Ital.); liquidambar or liquidamber (Mex., C. A., general); estoraque, maripenda, naba, ocotzotl, ocozol, ocozote, ocozotl, yaga-bito, yaga-bizigni (Mex.); goma colorada (Arg., introduced).

General properties: Color light to dark brown, often variegated with irregular black markings, producing beautiful figure. Sapwood yellowish or gray; not always sharply defined.

Without characteristic odor or taste.

Wood of medium hardness and density. Sp. gr. (air-dry) 0.50 to 0.65. Average weight about 35 lbs. per cu. ft. Grain rather irregular to decidedly so. Texture fine. Easy to work, finishes smoothly, likely to warp badly if not carefully dried, not very durable in contact with the ground.

Growth rings: Present, but not very distinct; due to slightly denser layer terminating seasonal growth.

Parenchyma: Not visible with lens.

Pores: Very small; scarcely visible without lens; abundant; well distributed without definite arrangement; angular in outline.

Vessel lines: Fine and indistinct.

Vessel contents: Tyloses common; red gum sometimes present.

Rays: Very fine and uniform; faintly visible on cross section; invisible on tangential; low and inconspicuous on radial surface.

Ripple marks: Absent.

Gum ducts: Vertical ducts of the gummosis type, with white or dark red contents, occasionally present in compact peripheral rows.

Minute anatomy: Vessels with many-barred scalariform perforations; scalariform bordered pits common; overlapping ends of segments spiral. Rays heterogeneous; one or two cells wide and few to 30 cells high; containing dark gum deposits; pits into vessels large, half-bordered to simple, often much elongated. Parenchyma diffuse, sparingly developed. Wood fibers rather thick-walled, in fairly definite radial rows; pits distinctly bordered.

Material: Yale Nos. 40, 179, 269 (Hond.); 3713 (Guat.).

23. PLATANACEAE

The Plane Tree Family consists of a single genus, *Platanus*, and about ten species of large trees, of which the best known are the European plane tree, *P. orientalis* L., commonly planted along streets in temperate regions, and the sycamore, *P. occidentalis* L., the largest hardwood tree in the United States.

There are seven species in Mexico, mostly along water courses in the northern part of the country, though at least one species, *P. chiapensis* Standl., occurs in Chiapas. They are commonly known as "alamo," "alamo blanco," and "aya." The trees are often very large, sometimes 125 feet high and over eight feet in diameter. The wood, which is similar in all respects to that of the plane tree and sycamore, is used locally to a limited extent for general carpentry work and for the manufacture of dishes and spoons. It is moderately hard and heavy, tough and strong, rather cross-grained and liable to warp in seasoning. The growth rings are fairly distinct; the pores are very small and crowded; the parenchyma is not visible with lens; rays are distinct on all sections and give rise to conspicuous silver grain on quarter-sawn lumber. As to the minute anatomy: Vessel perforations mostly simple, but not infrequently

scalariform with few bars; bordered pits sometimes scalariform. Rays fine-celled; homogeneous; pits into vessels half-bordered. Parenchyma in irregular tangential rows; cells small. Wood fibers thick-walled, with bordered pits.

24. AMYGDALACEAE

The Almond Family, corresponding to the sections Prunoideae and Chrysobalanoideae of the Rosaceae, consists of about 17 genera of trees and shrubs occurring in both temperate and tropical regions. The best known representatives are fruit trees, namely, the almond, apricot, cherry, peach, and plum. The genera of more or less importance for their timber in tropical America are *Prunus*, *Licania*, *Moquilea*, *Parinarium*, *Chrysobalanus*, and *Hirtella*.

The woods of the last five genera, judging from material available, have many features in common. The color is usually grayish or sometimes reddish. Unlike the others of the family, they show considerable development of parenchyma in fine, concentric, or wavy tangential lines suggesting the Lecythidaceae, though less regular. The pores are comparatively large and distinct and are not very numerous, and the rays are extremely fine. The vessels have simple perforations; the vessel-ray pits are of two kinds, half-bordered and simple—the latter often greatly elongated and sometimes in scalariform arrangement; the wood fibers have numerous and conspicuous bordered pits in their radial walls. The timber of these five genera has a wide range of uses, including heavy construction of all kinds, both on land and in water, general carpentry, railway cross-ties, posts and piling, fuel and charcoal. On the whole they seem poorly resistant to decay and rather highly resistant to the teredo, possibly on account of silica contained in the cells. Other important products for local consumption are edible fruits with seeds supplying oil for culinary and medicinal purposes, and bark and leaves which are used in medicine as astringents.

PRUNUS

The only important timber tree of this genus in the United States is the black cherry, *Prunus serotina* Ehrh., which supplies a beautiful and valuable wood for cabinetmaking and furniture. *P. occidentalis* Sw., is a common tree in the West Indies, where it attains a height of about 50 feet and a diameter up to two feet. It is known as "almendron" or "almendrillo" in Porto Rico and "cuajani" in Cuba. The wood has much the same properties and uses as our black cherry.

The "capulí," *P. Capuli* Cav., is a low tree with a trunk sometimes three feet in diameter, occurring from Sonora, Mexico, southward

through Central America to Ecuador and Peru. The wood is said to be of good quality and highly esteemed for cabinetwork and general carpentry. The trees are sometimes planted about houses on account of their large juicy fruit. The bark and leaves are employed medicinally.

Common names: Capulí, capulín, capolín (General); cerezo (Guat.); detze, ghoto, pa kshmuk, tnundaya, xeugua (Mex.).

CHRYSOBALANUS

Of the several species of this genus, the one best known is *Chrysobalanus Icaco*, L., an evergreen shrub or small tree up to 30 feet high, widely distributed along the coast of tropical America and western Africa. The wrinkled fruit is edible, though insipid, the seeds are rich in oil which is sometimes expressed for industrial purposes, and the bark, leaves, and roots are astringent. The wood, which is of a light brown color often tinged with red, is heavy, hard, and strong; rarely used except for fuel and minor local purposes. The structure is similar in nearly all respects to that of *Licania*.

Common names: Cocoa plum, gopher plum, pigeon plum; fat pork, pork fat apple (Eng.); hicaco, icaco, jicaco (W. I., C. A., Mex.); icaque, icaco (Trin.); icaque, icaque des bois (Guad.); guajurú (Braz.).

Material: Yale No. 5188 (Fla.).

COUEPIA

This genus consists of about 40 species of shrubs or medium-sized trees, occurring sparingly in western Africa and commonly in northern South America, Central America, and southern Mexico. The fruit of some species is prized by the natives, who often plant the trees about their dwellings. The seeds yield an oil used locally in cooking. The wood is said to be hard, heavy, strong, straight-grained; the darker-colored kinds are durable, and find various local employment where material of this class is needed. There is no authentic specimen available for study, but from published descriptions it appears that the structure is that typical of this group.

Common names: Oity de sertão, copuda, uchirana, parinari, umaryrana (Braz.); coupi, couepi, acioua (Fr. G.); olosapo (C. R.); ulezapote, ulozapote, uluzapote, zapote bolo, zapotillo, zapotillo amarillo (Salv.).

HIRTELLA

The 60 or more species of this genus are chiefly tropical American, a few occurring in western Africa. They are mostly shrubs or small

trees, occasionally reaching a height of 50 feet and a diameter of 12 to 15 inches. The wood, which is grayish or light brown, is straight-grained, hard, heavy, strong, tough, and moderately durable. It is used locally for fuel, charcoal, fence posts, and miscellaneous minor purposes. The bark is rich in silica and the ashes of it are sometimes used by the natives in the making of pottery and dishes; it is also employed as a tanning material and for medicinal purposes.

Common names: Hicaco prieto, icaco prieto, icaco de aura, teta de yegua (Cuba); teta de burra, teta de burra cimarrón, icacillo (P. R.); bois canari, cauto (Trin.); ajurú, comandatubá (Braz.); bois de gaulette (Fr. G.); kauta (B. G.); icaquillo, cajetillo (Mex.).

PARINARIUM

The 75 or more species of this genus, are mostly shrubs or small trees, though a few attain rather large proportions. They are very widely distributed in the tropical and sub-tropical regions of the southern hemisphere.

The wood of the "liúsin" of the Philippines, *Parinarium corymbosum* Miq., is not durable in contact with the ground or exposed to the weather, but it is rarely attacked by insects and is one of the most resistant of all woods to the attacks of teredo. It is accordingly used for salt-water piling, though it is necessary to protect the parts above water with artificial preservatives, such as thick coatings of paint or tar. The "foengoe" or "vonkhout" of Surinam, believed to be a species of *Parinarium*, has properties very similar to the "liúsin." The high resistance of the wood to the *Neo-teredo* is ascribed by Gonggrijp[69] to the presence of silica bodies in the cell cavities.

The best known American species is *P. campestre* Aubl. of the Guinas, Trinidad, and northern Brazil. It is a common tree in British Guiana, where it attains an average height of about 75 feet, with diameters of 24 to 30 inches. The wood, which is hard and heavy and of a uniform grayish-brown color with a pinkish hue, is little used, but deserves a trial for salt-water piling with the tops treated as stated above. The structure of the only available specimen of this wood (Yale No. 3033) is so similar to that of *Moquilea* that detailed description is omitted.

Common names:[70] Boohoorada, buhoorada (B. G.); beurata, buirata, foengoe ?, vonkhout ? (Sur.); petit parinari, nefle (Fr. G.); cauturo (Trin.);

[69] Gonggrijp, J. W.: Over Demerara greenheart, manbarklak en een nieuwe tegen paalworm bestande houtsoort, *West Indië*, 1921.

[70] The beautiful cabinet woods known as "satiné" are commonly referred to *Parinarium*, but this is a mistake, as "satiné rubanné" belongs to the Moraceae and "satiné rouge" probably to the Leguminosae.

parinari (Braz.). Other species: Pajurá (Braz.); ourourcou-merepa (Guianas).

LICANIA

This tropical American genus, with over 65 species, is especially well represented in Brazil and extends through northern South America and Central America to southern Mexico. Some of the species are shrubs, others are medium-sized trees, and a few are large and occupy a prominent place in the forest.

The Brazilian trees are common and well known, and supply considerable timber for many local uses. The wood is hard and strong and is employed in general carpentry and in heavy construction, but is not suitable for use in contact with the ground or in other places especially favorable to decay. Shingles are often made from it, owing to its straightness of grain and the ease with which it splits. Certain kinds make excellent charcoal. The fruits of some species are the source of a black dye and others furnish a kind of varnish.

The two best known species in the Guianas are *Licania mollis* Benth. and *L. heteromorpha* Benth. The former is said to be plentiful in the hilly lands of British Guiana, where it has an average height of 80 feet and trunks large enough to produce timbers squaring 14 inches. The wood is of a brownish color and has an unpleasant odor when fresh. It is very hard, heavy, and strong, but is only moderately durable in contact with the ground. While suitable for protected structures, the timber is not used extensively on account of the difficulty in working it.

L. platypus (Hemsl.) Pittier of Central America is a forest tree of stately proportions. The fruit, known in British Honduras as the monkey apple, is often over six inches long and four inches through; its yellow, juicy, and somewhat fibrous flesh is of a slightly acid flavor and is considered by some superior to the "zapote" (*Achras*). Two other species supplying some timber for heavy construction in Central America are *L. arborea* Seem. and *L. hypoleuca* Benth. The latter occurs also in the forests of Colombia and Venezuela, and its wood is taken as the type of the genus.

THE WOOD

Licania hypoleuca Benth. *Chozo.*

Common names: Chozo (Guat.-Hond.). Other species: Anauerá, caripé rana, caripé verdadeiro, macucú, macucú do Rio Negro, pintadinha (Braz.); icaque montagne, gaulette rouge (Guad.); bois gaulettes, anaoura, bois rouge tisane (Fr. G.); kautaballi, coutaballi, konoko, koonookoo (B. G.); bois gris, case (Trin.); icaquito (Venez.); alcornoque, zapote (C. R.); encina (Guat., Hond.); caca de niño, cacahuanche, cacahuate, cacahoanantzin, cacahoananche, caña dulce, frailecillo, palo de fraile, quirindal, quirindol cacahuan-

anche, totopostle, zapote amarillo, zapote borracho, zapote cabello (Mex.); canilla de mula, jobo, roble, súngalo, sunza, sunzapote (Salv.).

General properties: Color brownish-gray with a yellowish hue; not lustrous. Sapwood not clearly defined.

Odor and taste absent or not distinctive in dry specimens.

Very hard and heavy. Sp. gr. (air-dry) 1.03. Weight about 64 lbs. per cu. ft. Grain fairly straight to somewhat roey. Texture medium. Wood hard to cut, easy to split, finished surface dull; does not appear resistant to decay.

Growth rings: Present, but indistinct due to slight differences in depth of color and to wider spacing of parenchyma lines.

Parenchyma: In numerous fine, wavy, concentric lines; fairly evenly spaced; sometimes broken and anastomosing; spaces average about half the radial diameter of pores; occasional wider spacing, accompanied usually by smoother line, gives appearance of growth rings; lines barely visible without lens, but giving a hoary appearance on cross section, and producing fine pattern on tangential.

Pores: Small to medium; distinct; comparatively few; scattered irregularly; occurring singly or sometimes in broken radial or diagonal rows; mostly open.

Vessel lines: Appearing as straight, deep scratches; distinct.

Vessel contents: Tyloses abundant in some of the vessels.

Rays: Extremely fine and very numerous; less than half the width of the parenchyma lines; invisible on cross and tangential sections; low, but distinct, though not conspicuous, on radial surface, being darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Resembles *Chrysobalanus Icaco* (Yale No. 5188 of southern Florida) except that the pores are fewer. The parenchyma lines are finer, less broken, and more uniformly spaced than in available specimens of *Parinarium* and *Moquilea.*

Material: Yale No. 3727, collected with leaves and flowers along Guatemala-Honduras boundary by Whitford and Stadtmiller. Other species: Yale No. 5128 (B. G.); 5383 (Fr. G.).

MOQUILEA

This genus, with about 25 species, is confined to tropical America and has practically the same range as *Licania*, being most abundant and best known in Brazil. The "oity," *Moquilea tomentosa* Benth., is extensively planted in parks and along the streets, particularly in eastern and southern Brazil; the crowns are kept in shape by frequent trimming. The tree is common also in the forest, but has a short, thick bole 24 to 36 inches in diameter. The timber is heavy, hard, and strong, and is used in civil and naval construction and carpentry, and for fence posts, piling, and railway ties.

There are several Brazilian species, commonly called "caripé" or "caraipé," which attain good proportions, but their timber is not highly esteemed, being hard to work and of low durability in contact with the ground. The siliceous bark, however, is of great usefulness to the natives in the manufacture of fireproof pottery, comprising every kind of cooking utensil. In relating his experiences on the Amazon, Spruce[71] says of this pottery: "It was made of equal parts of a fine clay, found in the beds of igarapés, and of calcined caraipé bark; but in other places where I have seen the manufacture of pottery carried on (and there is no Indian's house in the Amazon Valley where it is not familiar) a much smaller proportion of the bark was used. The property which renders the bark available for this purpose is the great quantity of silex contained in it. In the best sorts—such as I afterwards saw on the river Uaupés—the crystals of silex may be observed with a lens even in the fresh bark; and the burnt bark turns out a flinty mass (with a very slight residuum of light ash, which may be blown away), so that for mixing with clay it requires to be reduced to powder with a pestle and mortar. The bark I saw at Caripi is, however, much less siliceous, and when burnt may be broken up with the fingers."

THE WOOD

Moquilea tomentosa Benth. *Oity.*

Common names: Oity (or oiti), oity da praia, aiti, guayti, oitiçica[72] (Braz.). Other species: Caripé or caraipé, oity-coroya (Braz.); sonsapote (C. R.).

General properties: Color dull brown with more or less purplish tinge. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.98. Weight about 61 lbs. per cu. ft. Grain usually straight. Texture medium to rather coarse. Wood hard to cut, easy to split, rather harsh and splintery. Does not appear resistant to decay, one specimen showing signs of rot.

Growth rings: Absent or only occasionally indicated by wider spacing of parenchyma lines.

Parenchyma: In very numerous, fine, irregularly wavy, concentric lines independent of the pores; often broken or anastomosing; spacing uneven, averaging about the radial diameter of pores; lines readily visible, but not conspicuous; at least twice as wide as the rays; produce finely layered effect on tangential surface.

Pores: Variable from rather large to rather small; the larger ones very distinct; not numerous; occurring singly and irregularly; mostly open.

[71] Spruce, Richard: *Notes of a botanist on the Amazon and Andes,* London, 1908, vol. I, p. 12.

[72] The name "oitiçica" properly belongs to *Clarisia* (Moraceae).

Vessel lines: Appearing as long straight and deep scratches; very distinct.

Vessel contents: Some tyloses observed; abundant in specimen No. 3190. White substance in some of the vessels in No. 3457.

Rays: Very fine; invisible or nearly so on cross section; invisible on tangential; distinct, but not conspicuous, on radial surface, where they are slightly darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The structure of the wood is very much like that of *Parinarium campestre* Aubl. (Yale No. 3033). In a specimen (Yale No. 3417) of a stem or branch one and one-half inches in diameter from Pernambuco, Brazil, collected by Mr. Curran under name of "oity," the parenchyma lines are very fine and indistinct, very wavy, and very closely spaced.

Material: Yale Nos. 3190, 3454, 3457, 3460, 3510 (Braz.).

25. LEGUMINOSAE

This enormous and highly important family consists of about 500 genera and 15,000 species of trees, shrubs, and herbaceous plants, with representatives in every country in the world. The herbaceous forms include such well-known and useful plants as peas, beans, clover, and alfalfa. Of the trees, perhaps the best known in the United States is the black locust (*Robinia pseudacacia* L.), though there are many others, such as the honey locust (*Gleditsia*), the red-bud (*Cercis*), and the Kentucky coffee tree (*Gymnocladus*). Many of the tropical timbers have been in the markets of the world for a very long time and are among the most valuable woods known for inlay and cabinetwork, musical instruments, carving, and manifold other purposes. To this family belong the logwood, brazilwood, and other important dyewoods. Many species are important as sources of food and forage, gums and resins, drugs and medicines, and some kinds are cultivated for ornament, for fences, or for shading plantations of coffee and cocoa.

There are in tropical America about 125 different genera which contain trees, the number of species varying from one or two upward into the hundreds. In a great many cases little or nothing is known about the woods, because the botanists who named the trees confined their attention to the leaves and the reproductive organs and ignored the wood. Even now there is uncertainty as to the identity of certain woods which have been in the world's trade for a great many years; for example, the Brazilian tulip-wood, a legume universally referred to as *Physocalymma* of the family Lythraceae. In fact, the information about the best known woods is often the most confused because of the numerous substitutes which are placed on the market to profit by the reputation of some other timber. There is need for extended research in this family,

and in order to establish the identity of the woods it is absolutely essential that the wood specimens be taken from the same tree from which herbarium material is collected. Until careful work of this nature is done the woods can be treated only in a very inadequate manner.

The woods of the Leguminosae exhibit almost every conceivable variation. In density they range from as light as cork to as heavy as lignumvitae. Their colors embrace the whole spectrum; in fact, a single specimen may be described as rainbow-hued; the most beautifully and highly colored woods known belong to this family. Many kinds are fragrantly scented, but their odors are usually impossible to describe with accuracy. A few kinds have a characteristic taste which may be pleasant, astringent, or bitter as quinine.

The texture varies from very coarse to very fine; the grain from perfectly straight to extremely irregular. The pores may be large or minute; few and scattering or numerous and crowded; uniform in size and distribution or in decidedly ring-porous arrangement. Tyloses and gum deposits may plug the vessels or be entirely absent. The rays vary from exceedingly fine to coarse, but are nearly always fine and inconspicuous. Perhaps the most characteristic feature of the woods is the parenchyma, which is usually abundantly developed about the pores or in tangential or concentric lines; numerous woods, however, are very deficient in parenchyma. Ripple marks are very common and when present provide one of the most helpful diagnostic characters. Vertical gum ducts are characteristic of a few genera and develop as a result of injury in several more.

As to the minute anatomy: The vessels invariably have simple perforations; occasionally they are provided with spiral thickenings. The bordered pits are commonly characterized by sieve-like perforations of their membranes, a feature not limited to this family, however. The rays may be uniseriate or multiseriate, homogeneous or heterogeneous; the pits into the vessels are usually half-bordered. The fibers have simple pits, are sometimes septate, may have a gelatinous inner layer, and the walls may be thick or thin.

From the foregoing it is evident that the woods of the Leguminosae have very few constant features. In spite of this, however, there is no other large group of woods so easily recognized, for although individual features vary, there are usually combinations of characters present which readily enable one familiar with woods to decide almost at a glance whether or not a specimen belongs to this family, even though he has never seen it before and has no knowledge as to the species, genus, or even the sub-family to which it belongs.

There are three divisions of the Leguminosae and some botanists con-

sider them separate families. These sub-families or families are (1) Mimosoideae or Mimosaceae, (2) Caesalpinioideae or Caesalpiniaceae, and (3) Papilionatae or Fabaceae.

25a. MIMOSOIDEAE

INGA

This genus consists of over 200 species of unarmed trees and shrubs widely distributed throughout tropical and southern sub-tropical regions of the New World. The leaves are even-pinnate, the leaflets few and large, the petiole often winged; the showy flowers are a veritable Mecca for bees and humming birds; the pods are large to very large, the seeds imbedded in a fleshy edible pulp. The trees are very common in the forests, particularly along streams, and some of them reach rather large dimensions. Many species are cultivated for decorative purposes or for the fruit or more commonly for shade and protection to plantations of coffee and cacoa.

The timber is not of commercial importance and is used only locally for fuel, charcoal, and miscellaneous minor purposes not exacting in their requirements, and especially where resistance to decay is not a factor. The woods exhibit considerable variation, but on the whole are light-colored (grayish or pinkish), often highly lustrous, and with little or no contrast between the heart and sap portions. Parenchyma is developed in varying amount, sometimes abundant in distinct patches about the pores and connecting them irregularly, and sometimes indistinct or apparently absent. The pores are generally large, numerous or fairly so, well distributed, and without definite arrangement. The rays are fine, usually invisible on cross section, invisible to fairly distinct on the tangential, and usually very distinct on the radial surface where they appear darker than the background. Ripple marks are absent, although the rays often produce a very irregular wavy pattern on tangential surface which sometimes approaches the formation of ripple marks.

Common names: Cuajinicuil, cuajiniquil, jinicuil, jinicuile, bitze, chelele, aguatope, guatope, timbre, vainillo (Mex.); cujin, cuajinicuil, paterno (Guat.); cuajinicuil, guayaniquil (C. R.); chapernillo, cujín, cujinicuil, guama, nacaspilo, paterno, paternillo, pepete, pepeto, pepetillo, pepito (Salv.); guabito peludo (Pan.); pacai, pacai de mono (Peru, Boliv.); guama, guamo, guama de machete, guama tapaculo, guamito (Col.); guamo, guamo peludo, guamo bejuco, guamo caraota, guamo de hierro, carbonero, orore (Venez.); guamo, pois doux (Trin.); guamá, guavá, guabá (P. R.); guamá, guabá (Cuba); awati, waikey, whykee, koroti waikey, pairowa waikey,

shirada waikey, maparakoni (B. G.); pois doux, pois doux blanc, pois doux gris (Guad., Mart.); pois sucré, pois sucré rouge, bois pagode, bougouni, cotonnier (Fr. G.); ingá, ingá-assú, ingá chichi, ingá-cipo, ingá doce, ingá ferradura, ingarana, ingajero, pacay (Braz.); ingá, ingá colorada, ingá de comer, ingá-guazú, ingá del cerro, ingá-pyitá, ingá-y (Arg.).

ENTEROLOBIUM

This genus consists of seven or eight species of timber trees which are widely distributed throughout tropical America. The available woods of the various species are, with one exception, very much alike in their structure and properties, and have the general appearance of walnut (*Juglans*), for which they are sometimes substituted. The resemblance is very close to the wood of the siris tree of India, *Albizzia Lebbek* Benth., known on the European markets as East Indian walnut.

On the basis of the wood structure, the "samán" or rain tree, *Enterolobium Saman* Prain, belongs to this genus, though it has been referred to at least seven different genera.[73] It is indigenous to Central America and parts of northern South America and is widely planted for shade in coffee and cacoa plantations and also in pastures, where it provides forage. It is occasionally found along streams in the forest, for example, along the Magdalena River in Colombia, where it attains a height of 100 feet and a diameter of four feet. It is more common, however, in open areas, where it is short-boled with an enormous, wide-spreading crown. The wood from young trees is light and soft, easy to cut, and of a brown color, but old trees yield hard, heavy, fibrous material that is very cross-grained and difficult to work, and the color is a deep chocolate-brown or almost black. The timber is of little or no commercial importance.

Common names: Rain tree (Eng.); samán (Venez., P. R.); campaño (Col.); guango (Jam.); samán, guango (P. R.); algarrobo del pais (Cuba); carreto, cenícero, zorra (Salv.).

Material: Yale Nos. 511, 1529*, 1595 (Col.); 2335* (Phil. Is.); 2723 (P. R.). Asterisk indicates botanical material.

The best known species of *Enterolobium* are *E. Timbouva* Mart. in southern South America, and *E. cyclocarpum* Gris. in northern South America, Central America, southern Mexico, and the West Indies. The first of these is common in both northeastern and northwestern Argentina where it is known as "timbó," and in the neighboring forests of

[73] *Enterolobium Saman* Prain = *Mimosa Saman* Jacq. = *Inga Saman* Willd. = *Pithecolobium Saman* Benth. = *Calliandra Saman* Gris. = *Albizzia Saman* F. Muell. = *Samanea Saman* Merrill.

Paraguay and Brazil, where it is usually called "timboúba." It reaches a height of 75 to 100 feet, with diameters up to six feet and clear lengths of 30 to 40 feet. The crown is composed of large, wide-spreading branches, making an umbrella-shaped canopy from 50 to 100 feet across. The large, finely pinnate leaves are deciduous and for a few months each year the trees are entirely bare. The flowers are small, white or yellowish, and borne in dense inconspicuous clusters. The fruits are black leathery pods shaped like a human ear and commonly called "orejas de negro" by the Spanish and "orelhas de negro" by the Brazilians, names which are also applied to the tree.

"Timbó" is well known to the trade in Argentina, although the amount of the lumber consumed annually probably does not exceed 100,000 board feet. It enters the market in the form of squared logs and because of its softness and ease of working is used as cheap substitute for cedar, and is sometimes known as "timbó cedro." The tree grows very rapidly and is often planted for shade. Some of the principal streets of Buenos Aires are lined with "timbó."

The same or a closely related species is common in São Paulo and eastern Brazil, where it is variously known as "tamboril," "tambory," "timboúba," "timbuva," etc. It attains large dimensions and specimens with trunks from six to ten feet in diameter are occasionally found. The principal use for the tree is in making large dugout canoes. The timber rarely enters the market.

Timber known as "guanacaste," "conacaste," "pichwood," "genizero," and South American walnut has been introduced into the markets of the United States, principally from Mexico and Central America, and is being used to considerable extent in California cities for interior trim in houses and office buildings. The species producing this is *Enterolobium cyclocarpum* Gris., a tree sometimes 125 feet or more in height, with a broad, spreading crown, a thick trunk sometimes 10 feet in diameter, and leaves and fruits similar to the "timbó" of Argentina.

Standley[74] says: "The tree grows rapidly and makes an excellent shade tree because of its broad top. The large trunks are used for canoes, water troughs, etc., and the wood is very durable in water. It is employed in carpentry and cabinet work. The pods are said to be an excellent feed for cattle, and the seeds as well as the young pods are sometimes cooked to be used for human food. The fruit and bark are rich in tannin. Rose reports that in Sinaloa the bark and fruit are used as a substitute for soap in washing woolen goods and that a syrup made from the bark is used for colds. The fruit is used as a soap substitute

[74] Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.*, 23: 2:391 (1922).

in Venezuela also. The gum which exudes from the trunk is employed in Sinaloa as a remedy for bronchitis."

The timber enters the United States markets as roughly hewn logs averaging about 24 inches in diameter and from 10 to 14 feet in length, usually free of defects. There is considerable variation in density of the material, ranging from the consistency of white pine (*Pinus Strobus*) to that of walnut (*Juglans nigra*). The heavier material resembles walnut in general appearance and makes a fairly satisfactory substitute.

THE WOOD

Enterolobium cyclocarpum (Jacq.) Gris. *Guanacaste.*

Common names: Guanacaste (Guat., Hond., Nic., C. R.); cuanacaztle, huanacaxtle, huinecaztle, nacaxtle, nacazle, cuau-nacaztli (Nahuatl word meaning "ear-tree"), cascabel sonaja, orejón, parota, piche (Mex.); guanacaste, conacaste (Guat.); guanacaste, genisero, jenizero (Nic.); conacaste, caro, caro hembra, arbol de orejas (Salv.); coratu, jarina, harina (Pan.); anjera, carita, carito, oriera, piñon (Col.); caro hembra (Venez.); oreja de judío, arbol de las orejas, algarrobo carretera, cabellos de Venus (Cuba); pichwood, South American walnut, Mexican walnut, conacaste, jenisero (Trade). Other species: Timbó, timbó atá, timbó cedro, timbó blanco ?, timbó colorado, timbó negro, timbó pyitá, timbó puitá, timboúba, timbaúva, pacará, pacará negra, pacará ploma, oreja de negro (Arg.); timboúba (Par.); tamboril, tambory, tambor, timbó, timboúba, timboúva, timbuva, timbahyva, tambuva, chimbó, ximbó, orelha de negro, monjolo, monjolo branco, monjolo cambuy, monjolo lizo, monjolo preto, monjolo vermelho, jacaré, vinhatico ? (Braz.).

General properties: Color walnut-brown or with various shadings; sometimes with a reddish tinge in part; luster rather high. Sapwood dull white, merging gradually into the heartwood.

Odor and taste absent or not distinctive.

Very light, soft and spongy to moderately hard and firm. Sp. gr. (air-dry) 0.35 to 0.60. Weight 22 to 37 lbs. per cu. ft. Grain straight to somewhat roey. Texture medium to coarse. Wood very easy to work, harder kinds take good polish, readily seasoned without warping and checking, fairly durable.

Growth rings: Present or absent; when present are chiefly due to color contrast and slight differences in density.

Parenchyma: About pores and pore groups, conspicuous on moist cross sections, sometimes uniting them into irregular patches and diagonal chains.

Pores: Rather large; fairly numerous; well distributed; occurring singly or in compressed radial groups of few to several pores each; very distinct, especially on moist sections, because of parenchyma; mostly open.

Vessel lines: Distinct to conspicuous; mostly long and straight.

Vessel contents: Localized dark gum deposits common.

Rays: Very fine; invisible or at limit of vision on cross section; faintly

visible on tangential; distinct, but fine and inconspicuous, on radial surface where they are darker than background.

Ripple marks: Absent. Tendency noted in one specimen (Yale No. 401).

Gum ducts: None observed.

Remarks: Judging from one small specimen (Yale No. 2983; Pittier's No. 5273), the wood of the "jarina" of Panama, *E. Schomburgkii* Benth., is considerably different from all the others. The sapwood is thick, yellowish, and sharply defined, the heart is reddish. The grain is straight, the texture rather fine, the wood is comparatively hard and heavy, though not difficult to cut. The parenchyma is often in diamond-shaped patches about the pores and occasionally confluent, with tendency here and there to the formation of tangential lines independent of the pores. The rays are faintly visible on cross and tangential sections and fairly distinct on the radial surface. Ripple marks and gum ducts are absent.

Material: Yale Nos. 3706*, 3737, 3742 (Guat.-Hond.); 6629 (Hond.); 4070, 4071, 5252 (Mex.); 5235 (Nic.); 4976 (Pan.); 401, 1526* (Col.). Other species: 1458, 2530, 3178 (Braz.); 540, 911, 946, 1040, 1056, 1737 (Arg.); 2893* (Pan.). Asterisk indicates botanical material.

PITHECOLOBIUM

This genus consists of over 175 species of shrubs and trees widely distributed throughout the tropical and sub-tropical regions of the world. The woods exhibit such an enormous range in structure and properties that the genus is obviously in need of revision. Few of the woods are of commercial importance.

THE CAT'S-CLAW GROUP

This group is composed of spiny trees and shrubs, of which the best known is *Pithecolobium dulce* (Roxb.) Benth. This is a small to rather large tree growing naturally in Mexico, Central America, and northern South America, and cultivated in various other parts of tropical America and in Guam, the Philippine Islands, and India.

Standley[75] says: "The tree is very resistant to drought. It is nearly evergreen, but loses its old leaves as the new ones appear. The wood is widely employed for general construction purposes, for fence posts, and for fuel. The bark yields a yellow dye, and is much used for tanning skins; it is used in domestic medicine, also, because of its astringent properties. The gum exuding from the trunk is transparent and deep reddish-brown; dissolved in water it makes good mucilage. The flowers are much frequented by bees and yield a good quality of honey. The

[75] Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb*, 23:2: 393-394 (1922).

fruit is highly esteemed in Mexico and is a common article in the markets. The acidulous aril surrounding the seeds is eaten and is used in the preparation of a beverage similar to lemonade. Stock of all kinds are fond of the pods, and in India monkeys are said to eat them greedily." The Nahuatl name for the tree, "coacha machalli" (and variants), signifies "snake-jaws," and refers to the fancied resemblance of the paired leaflets to the jaws of a snake. The leaves are often used medicinally. The tree is useful for hedges and will withstand clipping and chopping as well as the browsing of animals.

THE WOOD

Pithecolobium dulce (Roxb.) Benth. *Camachile.*

Common names: Auamúchil, buamúchil, cuamóchil, cuamúchil, guamúchil, guamúchitl, guamuche, guaymachile, guamachi, huamuche, huamúchil costeño, humo, muchite, pinzan, yaga-biguichi, yaga-bixihui (Mex.); espino de playa (Nic.); mochigüiste (C. R.); guachimole, mangollano, mongollano, espino (Salv.); jaguay (Guat.); ingá (Cuba); lawari (Curaçao); camachile (Guam, P. I.); karkapilly, vilayata imli, dakhani babul, kywèdanyin (India).

General properties: Color reddish-brown. Sapwood yellowish; not always sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy. Grain interwoven. Texture fine. Wood strong, but brittle, not easy to work, takes a high polish, is durable.

Growth rings: Usually distinct, due to parenchyma lines.

Parenchyma: In circles about the pores and in narrow, sometimes doubled or tripled, concentric lines apparently limiting seasonal growths; fairly distinct.

Pores: Small, but distinct on account of parenchyma; fairly numerous, but not crowded; well distributed; occurring singly or subdivided two to several times; often united into diagonal chains by parenchyma; mostly open.

Vessel lines: Fine, distinct, but not conspicuous; darker than background.

Vessel contents: Reddish or purplish gum deposits common.

Rays: Very fine; not visible on cross or tangential sections and scarcely distinct on radial surface.

Ripple marks: Absent; tendency to their formation noted.

Gum ducts: None observed.

Remarks: Closely resembles the cat's-claw, *P. Unguis-cati* Benth., of southern Florida and the British West Indies. Other names for this species are: Black-bead, bread-and-cheeses (Eng.); tzim-ché, tzin-ché (Mex.); espino de playa, uña de gato (Nic.); dinde (Col.); espinuelo (Venez.); manca montero, uña de gato (Cuba); rolon, uña de gato (P. R.); dabarouida (Curaçao).

Material: Yale Nos. 2816*, 2854* (Curaçao). Closely related species: 2775*, 2778*, 2798* (Curaçao). Asterisk indicates botanical material.

BAHAMA SABICÚ

Bahama sabicú is the trade name for the wood of *Pithecolobium arboreum* (L.) Urb., a tree growing on all the islands of the Antilles and in Trinidad, but not in the Bahamas; also along the east coast of Central America, and in Vera Cruz and Oaxaca, Mexico. It varies considerably in size and habit of growth in different parts of its range, but is sometimes 120 feet high and over three feet in diameter. The doubly pinnate leaves are bright green, large, often 16 inches long with numerous pinnate and fine linear leaflets; the flowers are white; the fruit is a bright red pod with black seeds.

The timber appears to have been first introduced into England in 1878 for use in making bobbins for the cotton mills. There was afterward a regular demand for the wood, most of which is said to have been supplied from Cuba. There are, however, two other Cuban woods known as "sabicú"; the brown one is the product of *Lysiloma Sabicu* Benth.; the purple one or "sabicú moruro" is from *Peltophorum adnatum* Gris. The tree occurs in Porto Rico and Jamaica, but apparently is used only locally. It is said to be almost as common as Spanish cedar in the interior of Haiti and Santo Domingo. The wood has the general appearance of mahogany (*Swietenia*) and some of it is beautifully figured. It is used in the West Indies and Central America for flooring, ceiling, posts, and general construction and carpentry. It is employed to some extent in the United States for cabinetwork and furniture.

THE WOOD

Pithecolobium arboreum (L.) Urb. *Bahama Sabicú.*

Common names: Bahama sabicú (Trade); wild tamarind (Jam.); cojoba, cojóbana (P. R.); moruro, moruro prieto, tengue (Cuba); coralillo, frijolillo (Mex.); conchido, loro, lorito (C. R.); cola de marano, cola de mico, quebracho ? (Guat.-Hond.).

General properties: Color dark red or reddish-brown; sometimes with darker stripes; not highly lustrous. Sapwood grayish; line of demarcation not sharp.

Odor and taste absent or not distinctive.

Moderately hard and heavy. Sp. gr. (air-dry) 0.74. Weight about 46 lbs. per cu. ft. Grain somewhat roey. Texture medium. Wood not difficult to work, finishes smoothly, appears to have good cabinet qualities and is durable.

Growth rings: Usually present, but not always distinct; limited by fine line of parenchyma; sometimes clearly indicated by differences in color.

Parenchyma: In prominent patches about the pores and often connecting them irregularly; also in fine lines apparently limiting seasonal growths; readily visible, but not conspicuous.

Pores: Rather large; distinct, due to parenchyma; fairly numerous; well distributed; occurring singly or subdivided; mostly open.

Vessel lines: Very distinct; mostly darker than background; in proper light the layer of parenchyma appears lighter than background.

Vessel contents: Dark-colored gum deposits common.

Rays: Very fine; not visible without lens on cross and tangential sections, and scarcely distinct on the radial surface.

Ripple marks: Usually present, but often very irregular; distinct in sapwood, but less so in heartwood; about 75 per inch.

Gum ducts: None observed.

Material: Yale No. 3676 with botanical material collected by Messrs. Whitford and Stadtmiller along Guatemala-Honduras boundary.

"GUAYACAN BLANCO"

The "guayacan blanco" of Cuba is said to be *P. obovale* Sauv. (= *Calliandra revoluta* Gris.); Mr. G. C. Bucher of Santiago writes as follows: "This is the principal wood used here in cart construction, particularly for the wheels. The tree grows in the dry deciduous forests of the foothills, and never attains very large size, although the trunks are usually long and straight. The largest stick I have ever seen was 65 inches in circumference. The timber is sold locally by the yard, lineal measurement, and a lot has to contain a good proportion of logs not less than 13 inches in diameter to be suitable for the manufacture of hubs."

The wood is pale brown with lighter and darker shades: hard and strong, finely roe-grained, fine-textured, fairly easy to work, and takes a high polish. The parenchyma is in numerous wavy lines which include the small pores and also in finer and more regular lines which apparently limit growth rings. The rays are very fine, faintly visible on cross section, invisible on tangential, indistinct on radial surface. Ripple marks are present, fairly regular, faintly visible, about 110 per inch. *Material:* Yale No. 4941, supplied by Mr. Bucher. Other Cuban names for this species are: Humo de sabana, cenizo, and ojo de cangrejo.

"VINHATICO DE ESPINHO"

The "vinhatico de espinho" or spiny "vinhatico" of the Bahia region of Brazil is a large, well-formed timber tree growing as scattered individuals, rarely more than two or three per acre, on upper hill slopes in association with the "vinhatico castanho" (*Plathymenia reticulata* Benth.). It attains a height of 100 feet, with a nearly cylindrical, slightly buttressed bole three to four feet in diameter and clear of branches for 40 to 50 feet. The bark is thin and smooth, becoming

somewhat shaggy on old trees. The young branches are armed with stout, straight, and sharp stipular spines often over an inch in length, while young sprouts are a veritable mass of thorns three or four inches long. The bipinnate leaves, which suggest those of the honey locust (*Gleditsia*), have a gland on the petiole below the insertion of the lowest of the four to six pairs of pinnae; the leaflets are small and crowded and bear numerous short coarse hairs such as occur also on the petioles, peduncles, and twigs. The flowers are yellow, nearly glabrous, small (the calyx tube two to three mm. long, the corolla about one cm. long), sessile, and spicate, the peduncles occurring one to three together in the axils of the leaves. The pods are small and contorted. Although closely related to the "jurema," *P. tortum* Mart., a low-branched crooked shrub or small tree, it is distinct in the character of its growth and in the structure of the wood. Since efforts to determine its identity have been unsuccessful, it will be referred to as *Pithecolobium Vinhatico.*

The wood is much like that of the "vinhatico de castanho" but retains its yellow color longer, has a waxy feel, and is much less common in the market, rarely entering the export trade. It has the same application as the other kinds of "vinhatico." (See pp. 222-225.)

The same species, or one closely related to it, occurs in Argentina, where it is known as "tataré" or "tatané." The trees are small, usually less than 50 feet high and 18 inches in diameter. Because of its scarcity the timber is not extensively used, but is considered excellent for general construction, carpentry, cabinetwork, carriage work, fine furniture, and shipbuilding. The wood is noted for its durability when exposed to the weather and is used locally for fence posts and other outdoor work. The fumes of the burning wood are unpleasant and to this fact is due the Indian name of "tataré," meaning "stinking fire."

THE WOOD

Pithecolobium Vinhatico Record — *Vinhatico de Espinho.*

Common names: Vinhatico, vinhatico de espinho, vinhatico de macaco, amarello (Braz.); tatané, tatané blanco, espinillo, tataré (Arg.); gold wood.

General properties: Color lustrous yellow, sometimes with lighter and darker shades, slowly turning brown superficially; injuries in heartwood may produce roseate discoloration. Sapwood white, sharply defined.

Odor and taste not distinctive.

Of medium hardness and weight. Sp. gr. (air-dry) 0.60. Weight about 37 lbs. per cu. ft. Grain fairly straight to roey. Texture rather fine. Wood not difficult to work, takes a high waxy polish, turns fairly well, seasons readily, holds its shape, appears durable.

Growth rings: Sometimes distinct due to differences in color and sometimes also to fine line of parenchyma.

Parenchyma: In patches, often diamond-shaped, about the pores and sometimes joining them into diagonal chains; sometimes also in fine indistinct concentric lines, often widely spaced.

Pores: Of medium size; readily visible; rather numerous, but not crowded; well distributed; occurring singly or occasionally subdivided two to several times; with tendency to arrangement in diagonal rows; open.

Vessel lines: Rather fine; distinct, but not conspicuous. Wood over vessels tends to rise after surface is finished, making the surface feel prickly if rubbed the wrong way of the grain.

Vessel contents: Some gum deposits noted.

Rays: Very fine; indistinct to invisible on cross section, invisible on tangential, visible, but inconspicuous, on radial surface, being of the same color as the background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The wood of *Pithecolobium tortum* Mart. differs from this in being harder, and in having considerably smaller and more numerous pores, more abundant parenchyma, and finer rays; there is also a difference in the color, though both woods are yellow.

Material: Yale Nos. 1806 and 4698 collected by Curran with botanical material, Bahia, Brazil; also 891, 920, 959, 1036 (Arg.).

"BOIS SERPENT"

There appears to be some question as to the identity of the "bois serpent" of French Guiana. Stone[76] calls it *Stryphnodendron guianense* Benth. (= *Mimosa guianensis* Aubl.), but Bertin[77] refers to it as *Pithecolobium racemiflorum* Ducke. Information supplied by Mr. C. Wactheimer tends to confirm this, as does also the statement of Ducke[78] regarding the nature and peculiar appearance of the wood of this species, known to the trade as "angelim rajado." Ducke also says that this wood is sometimes confused with that of *Hymenolobium*,[79] called "angelim." According to the same authority the trees are of common to fairly common occurrence in the sparsely settled portions of Faro, Oriximiná, Santarem, Tapajoz, Almeirim, and Gurupá, and the vernacular name is "ingá-rana." Ducke's description of the wood leaves no doubt as to its being the same as that in Guiana.

The "bois serpent," according to Bertin (*loc. cit.*), is a rare tree

[76] Stone, Herbert: Les bois utiles de la Guyane Française, *Ann. Mus. Col. Marseille*, 3d ser., 5: 3: 132-135 (1917).

[77] Bertin, A.: Les bois de la Guyane Française et du Brésil, *Miss. For. Col.*, 5: 79-80 (1920).

[78] Ducke, Adolpho: Plantes nouvelles ou peu connues de la région amazonienne, pt. II, *Arch. Jard. Bot. Rio de J.*, Rio de Janeiro, 1922, pp. 68-69.

[79] A specimen (Yale No. 5942) from the Amazon region of Brazil is labeled "Angelim rajado. *Hymenolobium pulcher.*"

with a bole free of branches for 60 to 80 feet, varying in diameter from 18 to 24 inches, the base heavily buttressed. The bark is rough and irregular; the leaves are alternate, doubly pinnate, and bear nectaries on the petioles; the flowers are small, yellow, and collected in numerous heads; the fruit is a curved pod, very pubescent, 6 to 8 cm. long and 8 mm. wide. The wood is light brown, pencil-striped with vessel-parenchyma lines, and irregularly marked with peculiar tracings in purple. It is very hard and heavy, specific gravity 1.15 to 1.25, difficult to work, highly durable. The natives use it in wheelwright work, but it is suitable for furniture and marquetry.

There is considerable confusion in the literature regarding the wood, due to the fact that many of the names given to it, *e.g.*, Surinam snakewood, zebra wood, "hoobooballi," "cassie," etc., are applied to, or suggest, entirely different woods.

THE WOOD

Pithecolobium racemiflorum Ducke — *Bois Serpent.*

Common names: Bois serpent, bois zebra, cassie, hoobooballi ? (Fr. G.); slang houdou, snecki housou, bousi tamarin, puta locus (Sur.); pashaco, ingá-rana, angelim rajado (Amaz., Braz.); Surinam snakewood, zebra wood (Misc.).

General properties: Color pale brown with irregular black or purplish stripes that are very conspicuous and characteristic; also with fine pencil-striping of light-colored vessel lines. Sapwood of lighter color, not sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) 1.15. Weight about 71 lbs. per cu. ft. Grain fairly straight. Texture medium. Wood very strong and tough, horn-like, difficult to work, finishes smoothly and takes a high polish, appears durable.

Growth rings: Absent or poorly defined; sometimes indicated by parenchyma lines.

Parenchyma: Abundantly developed; about the pores and extending in rather coarse wings which often are confluent; sometimes in tangential lines of irregular width; very distinct on all sections.

Pores: Rather small, but distinct on account of parenchyma; not very numerous; well distributed; occurring singly or occasionally subdivided; open.

Vessel lines: Very distinct due to parenchyma, appearing lighter than background.

Vessel contents: Occasional gum deposits observed.

Rays: Not visible on cross and tangential sections; visible, but inconspicuous, on radial surface, being lighter than background.

Ripple marks: Absent or only local tendencies to their formation.

Gum ducts: None observed.

Remarks: The structure is of the "sucupira" (*Bowdichia*) type. The wood is illustrated in Stone's publication (Ann. Mus. Col. Marseille, 3d ser., 4: 2, plates I-II, 1916).

Material: Yale No. 5392 (Bertin's No. 3034) (Fr. G.); 5942 (Amaz., Braz.).

MISCELLANEOUS

The wood of "samán" or rain tree, often referred to as *Pithecolobium Saman* (Jacq.) Benth., has the structure of *Enterolobium* and is described under that genus.

The "soto caballo" of Costa Rica, *P. cognatum* Benth., and the "paleto de blanco" of Guatemala-Honduras, *Pithecolobium* aff. *cognatum* Benth., are small trees with a lustrous white or yellowish-white wood. The parenchyma is in numerous wavy bands widening out to include the small scattered pores, with much finer and more uniform lines at intervals apparently limiting growth rings. The rays are very fine and ripple marks are absent.

The "hooroowassa" or soapwood of British Guiana, *P. trapezifolium* Benth, is said to be a medium-sized tree with a moderately soft, coarse-textured, light brown or pinkish wood of some local utility. The roots and bark are used by the Indians as soap. The "aliku," "aliki," or "benda" of British Guiana is *P. latifolium* Benth.

There are various species of *Pithecolobium* in Brazil but, with the exception of the "vinhatico de espinho" (*P. Vinhatico*), they are apparently poorly known and of little economic importance. The local names for different species are: Avaremotemo, angeco vermelho, caá-ingá, faveira do matto, and jarandeuva.

A Mexican tree known as "chucum" in Yucatan and as "huisache" in Campeche, *P. albicans* (Kunth.) Benth., is said to produce a gum similar to that of the mesquite (*Prosopis*), while the pods contain 18 per cent of tannin and yield a black dye. A small tree known as "huajillo" in southern Texas, and as "guajilla," "tenaza" and probably also as "carbonera" in Mexico, is *P. brevifolium* Benth. The dark reddish-brown wood is very hard and heavy and is used locally for fence posts, fuel, and various minor purposes.

LYSILOMA

Of the various species of this genus, occurring mostly in the West Indies, Mexico, and Central America, the best known and most valuable is *Lysiloma Sabicu* Benth., a beautiful timber tree of Cuba. It is known there as "jigüe" and "sabicú," the latter name being also applied to *Peltophorum adnatum* Gris. and *Pithecolobium arboreum* Urb.

The timber remaining in Cuba is principally in the moist coves and along the small streams in the higher maestra so far from improved roads that the cost of logging and transportation over the rough country is usually prohibitive. The tree is rather short, usually less than 60 feet, with diameters up to two feet and clear lengths of 25 feet. The doubly pinnate leaves have numerous small leaflets; the flowers are in small heads covered with the hair-like stamens; and the fruit is a flat pod, four to five inches long and an inch wide. The bark of the old trunk separates into large plate-like scales or strips.

The chestnut-brown wood has many of the properties of mahogany (*Swietenia*) and black walnut (*Juglans nigra* L.) and is used for much the same purposes, particularly for furniture. It is much better known in Europe than in the United States. The largest single shipment of the timber into this country is said to have been in 1904 when 25 carloads were imported for interior trim of railway coaches. The wood is highly resistant to decay and is considered excellent for shipbuilding and all kinds of interior and exterior construction.

The same or a closely related species grows in other islands of the West Indies and also in Florida.[80] The woods from these sources are very similar to the Cuban "sabicú" but are of only local value because of their scarcity. Some of the species of this genus are only shrubs.

THE WOOD

Lysiloma Sabicu Benth. *Sabicú.*

Common names: Sabicú, Cuban sabicú (Trade); jigüe, jigüe blanco, sabicú, savacú, savicó (Cuba); wild tamarind (Fla.); sabicú, horseflesh (Bah.); xiaxek (Mex.); sabicuholz (Germ.).

General properties: Color lustrous chestnut-brown, sometimes with darker stripes. Sapwood thin, white; sharply defined.

Odor and taste absent or not distinctive.

Rather hard and heavy. Sp. gr. (air-dry) 0.77. Weight about 48 lbs. per cu. ft. Grain usually roey. Texture medium. Wood easy to work, finishes smoothly, takes very high polish, holds its place, is strong, but rather brittle, and very durable.

Growth rings: Variable; sometimes distinct due to differences in color and to fine line of parenchyma.

Parenchyma: In narrow circles about pores; visible, but not conspicuous, appearing somewhat lighter than background, especialy if section is moistened; also in very fine lines apparently limiting growth rings, and scarcely visible without lens.

Pores: Variable from small to large; readily visible; not very numerous;

[80] The Florida form, known as wild tamarind, has a lighter wood than the others; sp. gr. (oven-dry) 0.64 (Tenth Census).

mostly solitary, but occasionally subdivided; sometimes more numerous and larger in early wood tending to ring-porous structure; sometimes in diagonal rows; open.

Vessel lines: Rather coarse and prominent adding to the figure of the wood; parenchyma sheaths show in proper light.

Vessel contents: Dark-colored gum deposits common.

Rays: Invisible or nearly so on cross section, invisible on tangential, fine and inconspicuous on radial surface, appearing of same color as background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The other kinds of "sabicú" have red or purplish woods.

Material: Yale Nos. 741, 771, 2086, 4939*, 5012 (Cuba); 5231* (Fla.).

PROSOPIS

This genus consists of over 40 species and several varieties of spiny shrubs and trees occurring in dry regions from southern Kansas in the United States to Chile, and also in portions of tropical Africa, and southwestern and tropical Asia. The woods are hard, heavy, and extremely durable and find extensive use in localities where other timber is scarce, being especially valuable for fuel. Certain species have edible pods which serve as fodder for livestock and as food for the Indians. The range of some of these trees has been widely extended by planting.

The genus is most abundantly represented in Argentina and Uruguay and supplies more commercial timber there than elsewhere. Although there are many species, the bulk of the wood on the market is the product of *Prosopis nigra* Hieron. and *P. alba* Gris., and is known as "algarrobo."[81] The "algarrobo" forest usually consists of a dense thicket of thorny shrubs and stiff branches with an overgrowth of white quebracho (*Aspidosperma Quebracho-blanco*) and *Prosopis*. It is not uncommon to find 10 to 25 algarrobo trees per acre, but at best they are only 25 to 40 feet high with short twisted boles 12 to 18, rarely 24, inches in diameter. The trees have umbrella-like crowns and a group of them suggests an apple orchard. The leaves are pinnately compound with fine leaflets; the flowers are yellow and borne in clusters as in the honey locust (*Gleditsia*); and the twisted pods are 6 to 10 inches long, inclosing a thick, spongy, sweet pulp which contains the seeds. The pods are borne in profusion and make excellent fodder for mules, burros, and

[81] This name was originally applied in Spain to the "carrob" or St. John's-bread, *Ceratonia siliqua* L., an Old World tree with large brown pods containing a thick edible pulp. When the Spaniards came to the New World they applied the name to various similar and more or less closely related plants, for example, *Prosopis* and *Hymenaea*.

Photos by H. M. Curran.

Algarroba Trees in Argentina.

(Prosopis spp.)

horses and are also an important source of food for the Indians; in fact, during the fruiting season of the "algarrobo" it is very difficult to secure Indian labor. The wide distribution of the tree in Argentina is doubtless attributable to the Indians, since in the neighborhood of old settlements and about towns and villages it is the commonest and often the only tree.

"Algarrobo" occurs in commercial quantities throughout the Chaco and is exploited in the regions north and west of Buenos Aires, especially in the Province of Cordova. The bulk of the best timber accessible to the railways has been cut, but the tree renews itself readily from sprouts and is of fairly rapid growth, so that it continues to hold a place in the trade. The timber enters the market in the form of round logs from four to eight feet long, and is used for a great variety of purposes because it is easy to work, highly inert to changes in moisture, and very resistant to decay and to wear. Many streets in Buenos Aires are paved with "algarrobo," it being one of the few woods suitable for this purpose without antiseptic treatment. It is also used for hubs and felloes and is one of the best woods on the market for doors and window frames.

Extending further southward than the two species above mentioned is *P. Algarrobilla* Gris., commonly known as "calden." The wood is of somewhat lighter weight than the others and has a tendency to become ring-porous. The densest wood of all is that of *P. Kuntzii* Harmes, called "jacarandá," "itin," or "barba de tigre" (tiger-claw). This is a low tree without leaves most of the year, beset with large sharp spines, and yielding a dark purplish wood of almost flinty hardness. The "ñandubay" or "espinillo" of the drier forests of northern Argentina, *P. Nandubay* Lor., grows in pure stands over considerable areas, though it rarely exceeds 15 to 20 feet in height. The wood is much like the algarrobo and is common on the market in the form of posts.

In the corresponding zone north of the Equator are found various species and varieties of *Prosopis*, two of which are of considerable local importance. The screw bean or screw pod mesquite of the southwestern United States and the "tornillo" of Mexico, *P. pubescens* Benth., is, as its names indicate, characterized by twisted pods which are in a narrow straight spiral with 12 to 20 turns. These pods are so sweet that they can be eaten as picked without any special preparation, and are also used by the Indians for making a syrup, a fermented beverage, and a kind of flour.

Best known of all the species of *Prosopis* is the common mesquite, *P. juliflora* (Swartz) DC., growing in western Texas and eastern New Mexico in the United States, throughout most of Mexico, Central Amer-

ica, the West Indies, and widely distributed in South America. It was introduced into Hawaii by the Jesuits and has become a highly important timber in the drier regions of that country, supplying large quantities of fuel, stock feed, and affording abundant nectar for bees. It has also been naturalized in the Philippine Islands, Peru, and in Uruguay. In the latter country it is the only wood available in many sections remote from the forested belts along the rivers, and supplies fuel, posts, stakes, and wood for many purposes, and also food for man and beast.

This tree is one of the best known plants of Mexico and of the arid regions of the southwestern United States. In the driest situations it is reduced to a shrub and in the northern part of its range the shrubby form develops enormous underground stems (known in Chihuahua as "cepas"), which make excellent firewood in regions where little else is obtainable, though involving a great deal of labor in removing them from the ground. The smaller roots penetrate to great depths in search of water, sometimes, it is said, to as much as 50 or even 75 feet. The largest trees are found in the river valleys where heights of 40 feet and diameters of four feet are not uncommon. On the plains and mesas it frequently forms thickets or forests many miles in extent resembling orchards of peach or apple trees.

The wood is valuable for railway ties, vehicle construction, fence posts, and especially for fuel, and in Texas is sometimes used for paving blocks. Its uses are limited only by the small sizes of the timber. An amber-colored, translucent gum, similar to gum arabic, exudes from the trunk and is used for making mucilage, as an ingredient in medicine, and for various other purposes. The bark, as is also the wood, is used in tanning; the inner bark of the stem is used medicinally; and that of the roots supplies fiber for cordage and coarse fabric. The flowers are much frequented by bees and yield a good grade of light-colored honey, and the Pima Indians sometimes eat the flower spikes after stripping off the flowers between their teeth. The pods are sweet, the pulp being composed of 25 to 30 per cent of grape sugar, and are an important source of forage for stock of all kinds. They have long been an article of human food in America, and among some of the Indian tribes, as with the Pimas, they were the chief food staple, being ground into a meal after the seeds and coarser parts had been removed. The meal is made into cakes (known in Mexico as "mesquitamales") which are baked, or it is mixed with water to form a beverage known as "mesquitatole," or fermented to make a kind of beer.[82]

[82] Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.*, 23: 2:351-352 (1922).

THE WOOD

Prosopis juliflora (Swartz) DC. *Mesquite.*

Common names: Mesquite, honey locust, honey pod, ironwood, algaroba (U. S.); mezquite, mezquite blanco, mezquite amarillo, mezquite colorado, mezquite chino, misquitl, guisache, chúcata, tziritzequa, algarroba, chachaca, ttâhî, tepemezquite ? (Mex.); acacia de Catarina (Nic.); manca-caballo (Pan.); carbón (Salv.); algarroba (Peru, Arg., Urug., Hawaii); cashaw (Jam.); indjoe, wawahi (Curaçao); bayahonda (Haiti); aroma (Phil. Is.). OTHER SPECIES: Screwbean, screw-pod mesquite, screwbean mesquite, mescrew (U. S.); tornillo (Mex.); curarier, yaque blanco, yaque negro (Venez.); coji (Curaçao); algarobo (Braz.); algarrobo, algarrobo amarillo, algarrobo blanco, algarrobo morado, algarrobo negro, algarrobo ñandubay, algarrobo panto, algarobillo, arbol blanco, arbol negro, barba de tigre, calden, cama tala, espinillo, espinillo ñandubay, ibopé-hú or ybopé-hú, ibopé-morotí, ibopé-pyitá, ibopé-saiyú, lamer, lingue, ñandubay, ñandubai, retorton, quilin, tintitaco, vinal, visnal (Arg.); algarrobo cupesi (Boliv.).

General properties: Color rich dark brown or mahogany, with fine, wavy, dark-colored vessel-lines usually bordered with lighter-colored parenchyma that is distinct in proper light; not highly lustrous. Sapwood yellow, usually thin.

More or less fragrant; suggesting violets. Taste not distinctive.

Rather hard and heavy. Sp. gr. (oven-dry) 0.77 (Tenth Census). Weight about 48 lbs. per cu. ft. Grain irregular. Texture rather coarse. Wood tough and strong, easy to work, finishes smoothly, but does not take a high polish, holds its place exceptionally well, is highly resistant to decay.

Growth rings: Distinct to indistinct; ring-porous in United States, diffuse-porous when grown in the tropics; in latter case rings are sometimes indicated by terminal parenchyma.

Parenchyma: Very abundantly developed; in masses about the pores and connecting them in wavy and often anastomosing bands of variable width, sometimes as wide as or wider than the fiber layers; usually very distinct on cross section, but less so on the longitudinal because of the lack of color contrast with background, though the degree of distinctness depends upon the lighting.

Pores: Variable from small to large; mostly distinct; irregularly disposed; often tending to form tangential or diagonal rows; U. S. specimens ring-porous, though some of the pores in late wood may be as large as those in early wood; occurring singly or in groups; mostly filled with dark-colored gum.

Vessel lines: Very distinct on account of gummy contents; finely wavy; layer of parenchyma is of about the same color as background but is of much lower luster than fiber areas and appears lighter when viewed at proper angle. The vessel lines are perhaps the most distinctive feature in all species of *Prosopis.*

Vessel contents: Dark-colored gum very abundant, filling the vessels or giving them a beaded appearance.

Rays: Fine, but visible, on cross section; invisible on tangential; inconspicuous on radial surface.

Ripple marks: Absent.

Gum ducts: None observed in authentic specimens, but it is not unlikely canals of the gummosis type sometimes occur. Some of the vessels resemble gum ducts.

Remarks: Although the woods of the different species of *Prosopis* exhibit considerable range of variation in density, color, and structure, nevertheless they form a fairly distinct group which is usually easily recognized. The diffuse-porous wood of *P. juliflora* is typical of the genus. In *P. Kuntzii,* however, the wood is of flinty hardness, of a deep purplish-brown color, and parenchyma is not very abundantly developed.

Material: Various unnumbered specimens from southwestern United States. Also Yale Nos. 2755*, 2764*, 2812* (Curaçao); 6652 (Venez.); 5027 (S. D.); 4479 (Hawaii). Other species: Yale Nos. 518, 527, 533, 895, 915, 925, 942, 943, 950, 951, 956, 978, 984, 985, 986, 990, 1011, 1035, 1041, 1053*, 1070, 1074*, 1077*, 1093, 1097, 1122, 1130, 3987, 3988, 3989, 5285, 5297 (Arg.); 4379, 4397 (Par.); 2858* (Curaçao). Asterisk indicates botanical material.

PIPTADENIA

This genus consists of more than 50 species of trees and shrubs widely distributed throughout the tropics of the world, and especially abundant in Brazil where the name usually applied to them is "angico." Although some of the species yield very useful wood, their principal value is in their bark which is a very important source of tanning material. Some species are planted for shade and decorative purposes along streets and in parks.

"ANGICO"

One of the best known species is the "angico," *Piptadenia rigida* Benth., of southern Brazil and northern Argentina. It attains a height of 100 feet, with a slightly irregular, but not heavily buttressed bole sometimes four feet in diameter and free of branches for 50 feet. The crown is widespreading and heavy-limbed; the leaves are doubly pinnate with a great many fine leaflets; the flowers are inconspicuous; and the fruit is a thin pod with scalloped margins. The wood is used for fuel and heavy construction, but is not an important factor in the markets.

THE WOOD

Piptadenia rigida Benth. *Angico.*

Common names: Angico, angico vermelho, angico verdadeiro (Braz.); angico, angico colorado, anchico colorado, curupay-rá (Arg.). Other species: Angico, angico branco, angico amarello, angico coco, angico escuro, angico preto, arapiraca, jacaré, paricá, espinho roxo, surucucú, curupay (Braz.);

cebil, horco cebil, cebil colorado, ibirá-ré, ybirá-ré curupay (Arg.); curupa-y (Boliv.); huilca, huilca romana, tarahuilca, ckara-huilca (Peru); cojoba, cojobana, cojobillo, cojobo (P. R.); lengua de vaca, quebracho (Salv.).

General properties: Color rather pale reddish-brown; fairly lustrous; mahogany-like. Sapwood thick, pinkish gray; distinct, but not very sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.95. Weight about 59 lbs. per cu. ft. Grain somewhat roey. Texture medium. Wood fairly easy to work, finishes smoothly, takes a high polish, appears durable.

Growth rings: Fairly distinct, due to slight differences in color, and also to fine lines of terminal parenchyma.

Parenchyma: In narrow circles about the pores, giving them the appearance of white dots; sometimes uniting them irregularly; distinct, but not conspicuous; also in fine, widely spaced concentric lines.

Pores: Of medium size; distinct on account of parenchyma; numerous but not crowded; well distributed; occurring singly or subdivided; sometimes showing diagonal or tangential arrangement; open.

Vessel lines: Rather fine, but very distinct, appearing darker than background.

Vessel contents: Gum deposits common.

Rays: Very fine; invisible on cross section; sometimes faintly visible on tangential in sapwood, low and scarcely distinct on radial surface, showing little contrast with background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The name "angico" is applied to various woods, some of which do not correspond closely to this description, which is taken from a specimen (Yale No. 1703) collected by Mr. Curran with fertile botanical material and identified as *P. rigida.* It is very distinct from the common "curupay" of the Argentine market.

Material: Yale Nos. 1703, 1735* (Arg.).

"CURUPAY"

This name is applied to more than one species of *Piptadenia*, and the "curupay" best known in the Argentine markets is of uncertain identity. Its principal source seems to be the lowland forests of Paraguay and there is little authentic information available concerning it, though it is said to be a large tree and fairly abundant. It also occurs in parts of southern Brazil. The timber enters the market in the form of squared logs, and is used for all sorts of heavy durable construction, being preferred to quebracho (*Schinopsis*) in places where the wood has to be worked with tools. It is too hard, however, for furniture and general carpentry, though of beautiful figure and color and taking a high polish.

THE WOOD

Piptadenia sp. *Curupay.*

Common names: Curupay, curupay negro (Arg.); curupay (Braz.).

General properties: Deep red with vaguely defined black stripes; fairly lustrous; appears oily, suggesting "urunday" (*Astronium*). Sapwood pinkish; distinct, but not very sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) 1.03. Weight about 64 lbs. per cu. ft. Grain roey, texture medium. Wood difficult to work, finishes smoothly, takes a high polish, is very tough, strong, and highly durable; feels oily.

Growth rings: Poorly defined; indicated by differences in color.

Parenchyma: About pores and sometimes uniting them irregularly; more abundantly in some specimens than in others; inconspicuous and sometimes scarcely distinct with lens; fine concentric lines apparently limiting growth rings present or absent.

Pores: Rather small, but visible; distinct to indistinct depending largely upon development of parenchyma; very numerous; fairly well distributed; occurring singly or subdivided, sometimes in short radial rows; mostly open.

Vessel lines: Fine, but very distinct, being considerably darker than background.

Vessel contents: Dark red or black gum abundant.

Rays: Faintly visible on cross section, usually invisible on tangential, inconspicuous on radial surface due to lack of color contrast.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Readily distinguished from "angico" by deeper red color and black markings and the greasy feel. "Urunday" is finer-textured, has its vessels filled with tyloses, has very little parenchyma, and some of the rays contain gum ducts visible with the lens as black dots on tangential surface. Resembles a specimen (Yale No. 1453) of "angico preto rajado" from Minaes Geraes, Brazil.

Material: Yale Nos. 904, 916, 944, 1114, 1115, 5288 (Arg.); 4743 (Matto Grosso, Braz.).

PLATHYMENIA

This genus consists of two Brazilian species, namely, *Plathymenia foliolosa* Benth. and *P. reticulata* Benth. The latter is the better known and supplies one of the most useful woods in eastern Brazil where it is called "vinhatico castanho" or "vinhatico amarello." "Vinhatico" is a general name applied to a group of woods that are typically yellow in color and are easy to work. Some of them are as light and soft as Spanish cedar (*Cedrela*), while others are more in the class with the lighter grades of mahogany (*Swietenia*). The "vinhaticos" are the most common leguminous timbers found in the markets of the coast from Pernambuco to Rio de Janeiro and are in great demand for the manufacture of the

best grade of furniture, much more so than the rosewood (*Dalbergia nigra*). When stained red the woods resemble mahogany and they are sometimes sold in foreign markets under the name of Brazilian mahogany or yellow mahogany, as well as Brazilian yellow wood. The local uses of the woods vary according to the density and include cabinetwork and furniture, interior trim, door moldings, plain and parquet flooring, carriage finishing, boat- and ship-building, and general construction and carpentry.

The "vinhatico" of São Paulo is said by various writers to be *Enterolobium ellipticum* Benth.; the "vinhatico de espinho," *Pithecolobium tortum* Mart.; the "vinhatico do campo," *Plathymenia* spp.; "vinhatico amarello," *Echirospermum Balthazarii* Fr. Allem. The "vinhaticos" in the Yale collections are readily classified into two groups and herbarium material accompanying some of the specimens of each group shows that the "vinhatico de espinho" is a species of *Pithecolobium*, while the more generally used timber, which is called "vinhatico castanho" in reference to the brown color which the surface of the wood soon assumes upon exposure, is *Plathymenia*. Market specimens of "vinhatico," "vinhatico amarello," and "vinhatico flor de algadão" as well as the "vinhatico castanho" from Pernambuco, Colonia, Bahia, and Rio de Janeiro, agree with the authentic specimens of *Plathymenia*. There are no specimens of the "vinhatico" of São Paulo in the Yale collections, but from the descriptions given by various writers it appears that there is more than one kind and it is likely that they will be found to belong to the two genera *Pithecolobium* and *Plathymenia*. Authentic specimens of *Enterolobium ellipticum* Benth. are not available, but from a study of many other woods of this genus it seems unlikely that a lustrous yellow wood like "vinhatico" could be a product of it.

The range of *Plathymenia* is poorly known. According to Correa,[83] *P. foliolosa* Benth. occurs in Piauhy, Ceará, Bahia, Minas Geraes, and Matto Grosso; *P. reticulata* Benth., in Amazonas, Bahia, Minas Geraes, São Paulo, and Goyaz.

In the forests of the Rio Doce region, *P. reticulata* is a tree reaching a height of 120 to 130 feet with a diameter over three feet and clear lengths of 60 to 70 feet. The trunk is straight and cylindrical, practically without buttresses, and is covered with a grayish or brownish bark that tends to become shreddy. The leaves are doubly pinnate with numerous small leaflets suggesting the honey locust (*Gleditsia*). The fruit is a rather large, thin, flat, brown pod with numerous flat, rectangularly winged seeds. The trees are nowhere abundant, but scattered

[83] Correa, M. Pio: *Flora do Brazil*, Rio de Janeiro, 1909, p. 72.

through the forests, rarely as many as three per acre, and are more common on the upper slopes than along the rivers. There is still an abundant supply in the interior, but the more accessible timber has been largely cut along with the rosewood (*Dalbergia nigra*) and brazilwood (*Caesalpinia echinata*). The finest specimens are in demand for dugout canoes and the natives search for them for distances of two or three miles from the streams. The timber is so highly appreciated by the Brazilians that there is very little available for export.

THE WOOD

Plathymenia reticulata Benth. *Vinhatico Castanho.*

Common names: Vinhatico, vinhatico castanho, vinhatico amarello, vinhatico flor de algadão, vinhatico de campo, vinhatico pé de boi, vinhatico testa de boi, vinhatico cabelleira, vinhatico orelha de macaco, amarello (Braz.); Brazilian mahogany, yellow mahogany, Brazilian yellow wood (Trade).

General properties: Color lustrous yellow or slightly orange, soon turning brown superficially; sometimes streaked. Sapwood thin, yellowish-white, rather sharply defined.

Odor and taste absent or not distinctive.

Light and soft to moderately hard and heavy. Sp. gr. (air-dry) 0.56 to 0.65. Weight 35 to 40 lbs. per cu. ft. Grain variable from straight to decidedly roey. Texture medium. Wood very easy to work, finishes smoothly, is tough and strong for its weight, is easy to dry and will hold its place, appears durable.

Growth rings: Poorly defined; sometimes fairly distinct due to differences in density and color.

Parenchyma: About pores and pore groups rarely united therein; fairly distinct on moist cross section; indistinct on dry; occasionally in very fine line at limit of growth rings.

Pores: Medium-sized to large; distinct; fairly numerous; rather irregularly disposed, sometimes considerably more numerous in early wood of growth rings; occurring singly or subdivided radially two to several times; open.

Vessel lines: Very distinct; of a reddish color.

Vessel contents: Reddish gum appears to line the vessels and is sometimes in local masses.

Rays: Invisible or nearly so on cross and tangential sections, low and uniform, but fairly prominent, on radial surface, appearing darker than background.

Ripple marks: Present or with tendency to their formation; very wavy and irregular at best; usually fairly distinct; 50 to 60 per inch.

Gum ducts: None observed.

Remarks: The "vinhatico espinho" (*Pithecolobium Vinhatico*) has no tendency to ripple marks, the vessel lines do not show prominently as red lines, the parenchyma is in diamond-shaped patches about the pores and often

connects them, the surface does not turn brown quickly, and the feel is waxy. The general appearance, however, is much like that of the "vinhatico castanho," especially when freshly worked.

Material: Yale Nos. 1468, 3103, 3214, 3271*, 3365, 3370, 3376, 3479, 3514, 3528, 3545, 3555, 4242, 4277, 4701* (Braz.). Asterisk indicates botanical material.

25b. CAESALPINIOIDEAE

DIMORPHANDRA

There are 12 known species of this genus, of which nine were described from Brazil, two from the Guianas, and one from Panama. The last, *Dimorphandra oleifera* Triana (= *D. megistosperma* Pittier), locally known as "alcornoque,"[84] is a tree upward of 150 feet in height, its straight trunk 35 to 50 feet long and sometimes over three feet in diameter, and covered with a rather dark, smooth, peeling bark. The buttresses exhibit much variation; at times they form large wings, usually three in number, extending up the stem to a distance of five feet or more; again they are low and scarcely noticeable. The main roots run horizontally and almost superficially, and can often be followed for nearly 50 feet from the trunk. The pinnate leaves are smooth and have only two pairs of leathery leaflets. The fruit is a leathery pod sometimes ten inches long and five inches broad, containing a single bean-shaped, lustrous, brownish-red seed, nearly seven inches long and five inches broad at the most—the largest seed of any dicotyledonous plant known. The natives extract a dark red dye from the seeds by infusion.

The tree is characteristic of the inner tidal belt of the Pacific coast of Panama, and forms extensive forests, extending for miles along some of the rivers. The timber, which is obtainable in large quantities, is now little used, though considered an acceptable substitute in many instances for oak and other heavy timbers, especially for structures kept permanently under water where attacks of teredo are not severe. The heartwood is reddish-brown; the sapwood is white and rather thick.

The best known species of this genus is the mora, *Dimorphandra Mora* B. & H. (= *D. excelsa* Baill. = *D. guianensis* Baill. = *Mora excelsa* Benth.) of the Guianas, where it grows in swamps or flat lands along streams, attaining heights of over 150 feet. The largest trees are very prominently buttressed and are usually hollow. Regarding the mora forests of Surinam, Percival[85] says: "Unlike the woods of tem-

[84] The significance of the name "alcornoque" (cork tree) is not clear, since the bark is thin and the wood is very hard.

[85] Percival, T. B.: The mora forests of Surinam, *Hardwood Record*, Chicago, Apr. 25, 1922, p. 38.

perate climates, the mora forests are made up of a variety of different kinds of trees, hardly two of the same species coming together, while their branches interlace so far above the ground that it is hard to tell those belonging to one trunk from those of its neighbors. In every instance the mora is predominant, but is found in commercial quantities only on the lower reaches of the Saramacca River, and hardly anywhere else in the Colony. A peculiar habit of the mora is that it flourishes best on the banks of the river and never extends inland further than half a mile." The principal use for the timber at present is for railway ties.

Mr. Miles Haman supplies the following notes regarding mora in British Guiana:

The "mora-trysil"[86] type of forest occurs on low-lying, moist, but not very swampy sites that are inundated during the wet seasons, but above the level of high tide, and is not limited to any particular parts of the colony. In one survey in this type near the Demerara River, mora was found to constitute 70 per cent of the stand with an average of 10 sound trees per acre. Trysil was next, making up seven per cent of the stand. The average stand of mora is from 10,000 to 15,000 board feet per acre. Where the mixture of other species is heavy, mora will run only about 3000 feet, but where it occurs pure, as it does in limited areas that are low and moist, stands of 25,000 to 30,000 feet are not uncommon. Mora will average between 100 and 150 feet in height, and sometimes will attain 200 feet. It is unquestionably the most distinctive tree of the British Guiana forest. The huge buttresses and flanges at the base spread out, on the larger trees, a distance of 15 feet from all sides of the trunk, and diameters of 8 feet, 20 feet above the ground, are not uncommon.

The wood springs in sawing, does not splinter readily, planes well, and takes nails better than greenheart. It is very resistant to decay, the heartwood being as durable as any wood in the colony; it does not, however, resist the teredo and other marine borers. The worst defect is water cracks in the heart. It seasons well when properly stacked. It is excellent for shipbuilding, framing and knees for punts, railway ties, paving blocks, house frames and under-pinning, fence posts, and all uses where resistance to decay is required. It is not a beautiful wood and hence is not in demand for furniture, but at present it is the most important wood in the colony.

The bark of the mora is rich in tannin and is credited with medicinal properties. The seeds make a good food for cattle and are also made into meal by the Indians for mixing with their cassava.

THE WOOD

Dimorphandra Mora B. & H. *Mora.*

Common names: Mora (B. G.); peto, mora, roode mora, witte mora, pala-

[86] *Pentaclethra filamentosa* Benth.

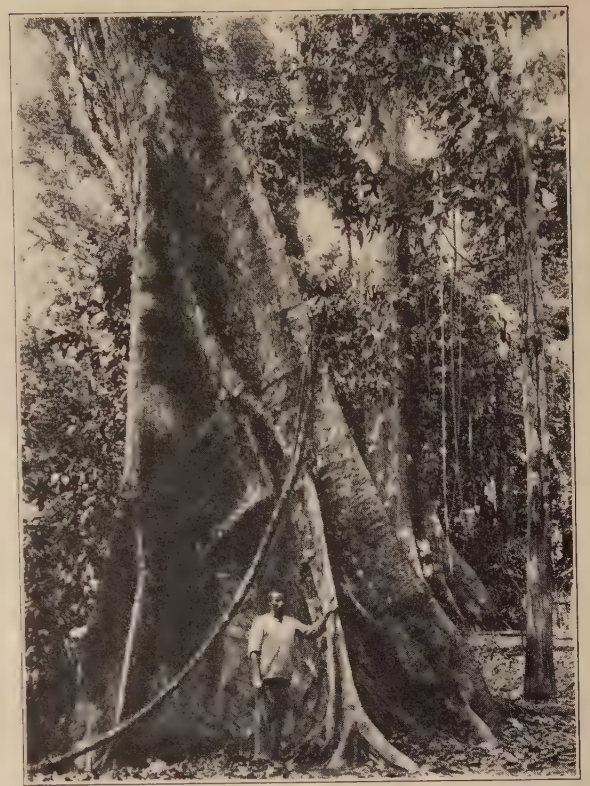


Photo by L. S. Hohenkerk.

Mora Trees in British Guiana.

(*Dimorphandra Mora.*)

Photo by C. S. Rogers.

Purpleheart in Trinidad.

(*Peltogyne sp.*)

PLATE XXVI

koea (Sur.); mahot rouge (Fr. G.); belarbre (Mart.); mora, muro (Trin.); moraholz (Germ.). OTHER SPECIES: Dakama (B. G.); alcornoque (Pan.).

General properties: Color reddish-brown, more or less streaked with lighter or darker lines or zones; has a "mealy" appearance. Thick sapwood yellowish; rather sharply defined.

Odorless. Taste bitter, though not pronounced at first.

Very hard and heavy. Sp. gr. (air-dry) about 1.00; (oven-dry) 0.87 (F. P. Laboratories of Canada). Weight (air-dry) about 62 lbs. per cu. ft. Grain straight or fairly so. Texture coarse and rather harsh. Wood hard to cut; finishes smoothly; strong, very durable.

Growth rings: Present, but not always distinct; due to fine line of parenchyma and sometimes also to differences in color and abundance of pores.

Parenchyma: In rather small, but very distinct, rounded masses about the pores and often uniting them irregularly into diagonal chains; also in occasional fine tangential or concentric lines independent of the pores, especially at limit of growth rings.

Pores: Of medium size; appearing very distinct on account of surrounding parenchyma; numerous; well distributed; occurring singly or in groups of two or three; no definite arrangement except as linked up into irregular chains by parenchyma.

Vessel lines: Distinct and sometimes conspicuous, due to parenchyma which appears lighter than background.

Vessel contents: White substance common.

Rays: Invisible or nearly so on cross section; faintly visible on tangential, producing a very fine mottling that is characteristic; visible, but low and inconspicuous, on radial surface.

Ripple marks: Absent; local tendency noted.

Gum ducts: None observed.

Remarks: In the wood of *Dimorphandra oleifera* the parenchyma is in coarse bands which include the pores. A wood called "morabucquia" is said to resemble the true mora and to be confused with it on the market.

Material: Yale Nos. 3032A, 4213, 5122, 5267 (B. G.); 4160, 4201 (Sur.).

PTEROGYNE

This genus consists of a single species, *Pterogyne nitens* Tul., the "ibiráro" of Argentina and adjoining regions in other countries. It occurs very scatteringly on the lower slopes and well-watered portions of the Andes in the provinces of Tucaman and Jujuy and also in the forests of Misiones and in southern Paraguay. Even where most common the trees will probably not average more than one per acre. It reaches a height of 100 to 125 feet with diameters up to four feet, the usual merchantable sizes, however, being from two to three feet. The bole is cylindrical and covered with a rather smooth grayish or brownish bark. The pinnate leaves bear some resemblance to those of the locust (*Robi-*

nia), and the small yellow flowers, borne in short racemes, are usually rather inconspicuous in the evergreen foliage.

The timber enters the larger markets of Argentina in the form of squared logs, and the total annual consumption probably does not exceed a million board feet. It is of excellent quality and is used for furniture, cabinetwork, interior trim, turnery, general carpentry, spokes and felloes, cooperage, railway ties, and fuel. The aqueous extract of the sawdust is purple and is sometimes employed locally for dyeing. The bark and leaves have a very bitter taste, which accounts for the Indian name "ibiráro" and the Spanish "palo amargo" (bitter tree).

THE WOOD

Pterogyne nitens Tul. *Ibiráro.*

Common names: Ibiráro, ybirá-ro, ybirá-ro-mi, palo amargo, palo mortero, palo rosa, tipa colorada, viraró (Arg.); ebiraro (Braz.).

General properties: Color light brown with a reddish tinge, deepening upon exposure, suggesting mahogany (*Swietenia*); sometimes with black streaks. Sapwood pinkish; not very sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy to moderately so. Sp. gr. (Castro) 0.765 to 1.086. Weight 48 to 68 lbs. per cu. ft. Grain finely roey. Texture medium. Wood strong, easy to cut, but rather difficult to finish because of irregular grain, takes a high polish, holds its shape, is durable.

Growth rings: Distinct; due to differences in density and color and also to terminal parenchyma.

Parenchyma: In narrow layers about the pores and sometimes connecting them irregularly; often also in lines, broken or continuous, apparently limiting growth rings; distinct, but not always conspicuous.

Pores: Of medium size, distinct on account of parenchyma about them; numerous; fairly well distributed, though sometimes nearly absent in narrow zones; occurring singly or subdivided two or three times; no definite arrangement except as connected here and there by parenchyma.

Vessel lines: Distinct; sometimes much darker than background; mostly short and sometimes in herring-bone arrangement due to roe grain.

Vessel contents: Reddish gum sometimes abundant; white substance occasionally found.

Rays: Extremely fine; not visible without lens on cross and tangential sections; fine and inconspicuous on radial.

Ripple marks: Present; faintly visible without lens; regular; all elements storied; number per inch, 90 to 100.

Gum ducts: None observed.

Material: Yale Nos. 909, 932, 1105, 1731, 1741, 4124, 4383, 5301 (Arg.); 4744 (Braz.).

PRIORIA

This genus consists of a single species, *Prioria Copaifera* Gris., a native of Jamaica and Panama. In Jamaica it attains a height of 100 feet and a diameter of three to four feet and grows in the upland. In Panama it grows over 150 feet tall and four feet in diameter, and belongs exclusively to the low forests that are permanently inundated, occurring on both the Atlantic and Pacific watersheds. The tree is known in Panama as "amanza muger," or more commonly "cativo," and is so abundant in some of the valley flats, such as are suitable for rice cultivation, that the natives call such districts "cativales." It has a smooth grayish bark; the leaves are compound, usually with two pairs of large leaflets; the small flowers are on branching spikes; the fruit is a rounded, flat, brownish pod with a single large, flat, edible seed. The timber is little used.

The wood is brownish and commonly stained with resinous exudations; the sapwood is usually thick and of a dingy white color. It is straight-grained, of medium to fine texture, cuts easily, and is moderately hard and strong. Parenchyma occurs about the pores and in numerous irregularly spaced tangential or concentric lines. The pores vary in size from very small to rather large, and are irregularly scattered. The rays are fine, faintly visible on cross and tangential sections, and fairly distinct on the radial. Ripple marks are absent. Vertical gum ducts are common and, being scattered, closely resemble the larger vessels except for their oily contents and more poorly defined margins. *Material:* Yale No. 2962 collected in Panama by Dr. Pittier; his No. 3971.

COPAIFERA (COPAIBA)

This genus consists of 35 or 40 species, principally in tropical South America and Africa. *Copaifera chiriquensis* Pittier grows in the forests of the low hills along the Pacific coast of western Panama and reaches a height of 100 feet and a diameter sometimes of four feet. The wood is little used. *C. Langsdorffii* Desf. is a common tree of São Paulo, Brazil, with trunks 25 to 30 feet long and 24 to 36 inches in diameter. The wood is used for cabinetwork, carriages, turnery, and shipbuilding, and the bark is sometimes employed in tanning.

The best known species is *Copaifera officinalis* (L.) Willd., growing naturally in northern South America and cultivated in the West Indies. This and closely related species are common factors in all the coast forests of tropical South America. The trees are slender and symmetrical, 100 to 125 feet tall, with diameters up to four feet. The crown is narrow and small-limbed; the bark is dark brown and rough;

the leaves are compound with few to several medium-sized leathery leaflets; and the fruit is a thick, one-seeded pod. The wood is common in the local markets and is used for interior trim and general carpentry and construction.

The woods of all species of *Copaifera* contain gum or oil canals which are the source of a commercial product known as copaiba balsam, copaiva balsam, balsam capivi, "balsamo de copaiba," "aceite de palo," etc. This is an oily liquid that collects in cavities in the heart of the tree and is gathered by tapping. The natives use it in a crude state for medicinal purposes and also for anointing their hair and bodies. It is used commercially as an ingredient in medicines and in the manufacture of varnishes. The principal sources of the oil are Venezuela and the Amazon region. The industry is not very extensive and is tending to decrease.

The woods of this genus are frequently confused with those of other species having an entirely different structure. One of these is *Hymenaea Courbaril* L., and in this instance the confusion is doubtless due to the fact that both trees yield resin. The reason for referring certain kinds of purpleheart to this genus is not clear, since the woods of this name examined by the authors do not have the characteristic structure of *Copaifera*. The same applies to the "quiebrahacha" of Cuba, said to be *Copaifera hymenaefolia* Moric., which is an extremely dense, fine-textured wood of a purplish-red color.

THE WOOD

Copaifera spp. *Copaiba.*

Common names: Copaiba (Eng.); copahyba, copahyba parda, copahyba vermelha, copahy, copahúva, copaúba, copaúva, páo olho, páo de oleo, oleo de copahyba, oleo de copahúva, oleo de copaúva (Braz.); copaiva (Peru); camiba, camibar, caniva (Pan.); canime, aceite de canime, copaiba, aceite de copaiba (Col.); aceite, cabima, cabimba (Venez.); copaiba, copahu (Fr. W. I.); amacei, copaiba (S. D.).

General properties: Color reddish-brown, variable; sometimes with dark, nearly black streaks; luster rather silky and golden in proper light; oily exudations sometimes present. Sapwood pinkish-gray, fairly sharply defined.

Odor and taste absent or not distinctive.

Moderately hard and heavy; variable in same specimen. Sp. gr. (air-dry) 0.70. Weight about 43 lbs. per cu. ft. Grain fairly straight. Texture fine to rather coarse. Wood easy to work, finishes smoothly, takes good polish, is strong and durable. The oily exudations are usually no defect.

Parenchyma: In concentric lines or bands rather widely spaced and apparently limiting seasonal growths; distinct; also in narrow, inconspicuous circles about the pores, but not extending wing-like from them.

Pores: Of medium size; readily visible; few and scattered; fairly evenly distributed; mostly single, but sometimes subdivided; open.

Vessel lines: Mostly long, rather fine, distinct, but not conspicuous.

Vessel contents: Gum deposits common.

Rays: Very fine; faintly visible on cross and tangential sections, distinct on radial surface, where they appear darker than background.

Ripple marks: Absent.

Gum ducts: Of normal occurrence in terminal parenchyma layers, sometimes very numerous, sometimes infrequent; small and indistinct without lens; presence indicated by exudations of small amounts of oil showing as streaks on longitudinal surface and as dark spots on cross section; sometimes appear as rows of white dots on cross section.

Remarks: The principal difference noted in the woods from different localities and species is in the density. The specimen (Yale No. 2961*; Pittier's No. 5263) of *C. chiriquensis* Pittier of Panama is, however, very distinct; having very numerous large pores, irregular bands of wood parenchyma, and numerous pith flecks. Since the specimen is from a small stem or branch the structure may not be typical.

Material: Yale Nos. 377 (Col.); 682, 1808*, 1935, 3110, 3118, 3146, 3192, 3201, 3253*, 3437, 3571, 3591*, 4287 (Braz.); 5057 (S. D.). Asterisk indicates botanical material.

HYMENAEA

This genus consists of about 30 species, one of which occurs in eastern Africa, the others in tropical America, especially Brazil. The best known and most widely distributed is the West Indian locust, *Hymenaea Courbaril* L., one of the most valuable timber trees in tropical America. It thrives best in sandy soil and is often 100 feet high with a lofty spreading crown and an immense trunk six to eight feet in diameter above the huge buttresses, and presumably of very great age. The leaves are compound, consisting of a pair of rather large, thick, and shiny leaflets at the end of the leafstalk, an arrangement which suggested the name *Hymenaea*, referring to Hymen, the god of marriage. The flowers are large, whitish or purplish, and the fruit is a rough, thick-walled pod, containing a few large bean-like seeds imbedded in a sweet pulp which becomes mealy and edible when the pod ripens.

One of the commercially valuable products of the tree is a pale yellow or reddish rosin-like gum usually known in the trade as South American copal to distinguish it from the various copals from other parts of the tropics. The exudations from the bark trickle to the ground and harden into lumps which eventually become buried in the soil. The gum gatherers dig around the roots and sometimes obtain a barrelful of copal lumps in a place, while the former site of a big tree, long since decayed, may yield several barrels of so-called fossil copal. Gum is also obtain-

able in small amounts by wounding the bark, but it is softer and less valuable, and is known in the trade as balsam or soft anime. The copal is employed chiefly in the manufacture of special grades of varnish, and to a minor extent for incense in churches, medicinal purposes, and as cement for mending broken crockery.

The bark is used by the Indians for making canoes. The process consists of removing the bark in one large piece, preferably from the standing tree, sewing it together at the ends with bush rope or bark-fiber cordage, waterproofing the seams with gum or resin; and then filling in a few wooden cross pieces to hold the shape. The bark of very old trees is often over an inch thick, and canoes with a carrying capacity of 25 to 30 men can be made from it.

The timber is of good quality and is used for carpentry, construction of all kinds, ship- and boat-building, treenails, furniture, cabinet work, and many other purposes. It is not considered highly durable in contact with the ground, though there is considerable variation in the wood in this respect. It was formerly well known in the European markets, but is less common now.

THE WOOD

Hymenaea Courbaril L. *West Indian Locust.*

Common names: West Indian locust, South American locust, leather-leaved locust, locust gum, Brazilian gum-copal tree, gum-anime tree, courbaril, courbaril plum (Eng.); locust, cimiri, courbaril, caouroubali, kawanari, kwanari (B. G.); locus, lokus, jengi kanda, lokisi kaka, Surinaamsch teakhout, Westindisch teakhout, julchihout, courabil hout (Sur.); courbaril, courbaril montagne, courbaril de savane, bois de courbaril, locustrier, cacachien, algarrobo, chimidida, caroubier de la Guyane, copalier de Amerique, diphylle pois confiture (Fr. G.); locust, stinking-toe, courbaril, algarobo (Trin.); algarrobo (Cuba); courbaril, marbre (Guad.); algarrobo, courbaril, quapinole jutahy, jatoba (P. R.); jatay, jetay, jataiba, jatobá, jatobá roxa, jatahy, jatahy roxo, jatahy peba, jutahy, jutahy café, jutahy assú, jutahy de campo, jutahy miry, jutahy pororoca, jutahy peba, jutahy catinga, jutahy roxo, yatayba, yutahí, yutahy, algarobo (Braz.); avati, abati timbary (Parag.); algarrobo, corobore (Venez.); algarrobo, nazareno (Col.); cuapinol, cuapinole, cuapinoli, coapinol, guapinol, guapinole, copinole, algarrobo (Mex., C. A.); lokustbaum, animebaum, henschreckenbaum (Germ.); bois de simire, bois de courbaril (Fr.); cannariboom, gom anime boom, locusboom, spruikhaanboom (Dutch); algarrobo, legno locusta (Ital.). (Various species are included in preceding.)

General properties: Color dark brown to orange, often with darker streaks, deepening upon exposure; rather dull. Sapwood rather thick; color dingy white, yellowish, or pinkish.

Odor and taste absent or not distinctive.

Hard and heavy, though somewhat variable. Sp. gr. (air-dry) 0.80 to

1.05. Weight 50 to 65 lbs. per cu. ft. Grain fairly straight to irregular. Texture medium. Wood tough and strong, not easy to work, finishes smoothly, but does not take a high polish; is fairly durable.

Growth rings: Distinct; due to rather widely and fairly uniformly spaced lines of parenchyma.

Parenchyma: In concentric lines or bands of variable width apparently limiting seasonal growths, sometimes two or three lines close together; distinct on all sections; also in patches about pores, tending to elongate tangentially and fairly distinct.

Pores: Rather large and distinct; few; scattered regularly; occurring singly or subdivided; mostly open.

Vessel lines: Very distinct; rather coarse.

Vessel contents: Gum and occasionally white substance present.

Rays: Fine, but visible, on cross section, often invisible on tangential, distinct and producing fine silver grain on radial surface.

Ripple marks: Absent.

Gum ducts: Vertical ducts occasionally present as result of injury.

Remarks: The name "algarrobo" is commonly applied also to *Prosopis* spp.; "jutahy peba" to *Dialium* and other woods in Brazil.

Material: Yale Nos. 1455, 3162, 3353*, 3900, 4018, 4674*, 4882 (Braz.); 3047, 4216, 5124 (B. G.); 4168, 4197 (Sur.); 2697 (P. R.); 438* (Venez.); 3711*, 3728* (Guat.-Hond.); 4731*, 4770 (Mex.). Asterisk indicates botanical material.

PELTOGYNE

This genus consists of a dozen or more species of trees with a range extending from São Paulo, Brazil, through the Amazon region and the Guianas to Central America and southern Mexico. They have compound leathery leaves with twin leaflets as in *Hymenaea*, the flowers are small and white, and the woods are noted for the rich purple color they assume upon exposure.

In Brazil the trees are commonly known as "guarabú" or "páo roxo." Mr. Curran says: " 'Páo roxo' is common in the Bahia coast forest and sometimes will yield 2000 to 3000 board feet per acre. At its best it attains a height of 125 feet and diameters up to four feet, though the usual commercial diameters are between two and three feet. The trunk is well formed, has no buttresses, is frequently clear of branches for 50 feet, and is covered with a smooth grayish-black bark. The sapwood of mature trees is from two to four inches thick. The heartwood is of a dull horn color when freshly cut and turns deep purple on exposure to the air. Logs and planks exposed to sun and rain soon lose their purple color and become black. The wood is as well known locally as the 'sucupira' and is considered the best material available for making spokes for cart wheels; in fact one rarely sees spokes made of any other wood."

Huber[87] says the "páo roxo" of the Amazon is in special demand for fancy joinery because of its beautiful color, and is also well suited for vehicle construction. *Peltogyne densiflora* Spruce is common on the shores of almost all the rivers of black water in the central Amazon region and the Rio Negro. Another species, *P. paraënsis* Huber, has been found only along the Capim River.

There are two or three species in the Guianas, the best known being *P. paniculata* Benth. The usual names are purpleheart in British Guiana, "purperhart" in Surinam, and "amarante" or violet in French Guiana. The wood has great strength and toughness and is used locally for mill beds, mortar beds, houseframing, and all purposes where shock has to be resisted, as well as for furniture, inlaying, and fancy articles of turnery. It is well known in European markets, where it is employed in cabinetmaking.

Little information is available regarding the genus in Colombia and northward. It is known to occur in Colombia and is called "tannaneo." The Panama species, *P. purpurea* Pittier, is a large low-branched, smooth-barked tree, called "nazareno" or "morado" on account of the color of the wood. The only authority for extending the range of the genus into Mexico is a wood specimen (Yale No. 4401) collected by Mr. John A. Gamon near Acapulco under the name of "palo morado." The structure and the rich purple color of this material leave no room for doubt as to the correctness of the identification.

Purpleheart is well known to American dealers in tropical hardwoods, but there has never been much demand for it. It has been used to some extent in the manufacture of billiard tables and cue butts and also in inlay and cabinetwork. The fact that it is so highly esteemed in Brazil for spokes suggests a similar use in the United States as a substitute for hickory (*Carya*), since here the color would not be objectionable as it would in the case of tool handles.

THE WOOD

Peltogyne spp. *Purpleheart.*

Common names: Purpleheart, purple wood, violet wood, amaranth (Eng.); amarante, bois violet (Fr.); amarantholz, violetholz (Germ.); purpuurhart (Dutch); legno amaranto, legno violetto, legno porpora (Ital.); madera purpurea, palo morado (Sp.); páo roxo, páo rojo, guarabú, guarabú branco, guarabú preto, guarabú rajado, guarabú roxo, guarabú vermelho, guarabussu, barabú, amarante, ellen grypho, roxinho (Braz.); morado (Boliv.); amarante, violet, bois violet, bois bagot ?, bois de coeur pourpre, bois pourpre (Fr. G.); purperhart, poerprehati, kooroobоo-elli, kooroobovelli, koroborelli,

[87] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 180 (1909).

hoepelhout, zeedrat ? (Sur.); purpleheart, saka, sacka, saka-balli, koruburelli, marawineroo (B. G.); purpleheart, sapater, zapatero (Trin.); tannaneo (Col.); nazareno, morado (Pan.); palo morado (Mex.).

General properties: Color dull brown when fresh; becoming uniformly purple or decidedly purplish when exposed. The colored portion is superficial, but newly exposed brown portions, even of thoroughly dry wood, will soon acquire the characteristic purple color. Sapwood white, becoming streaked with purple; sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) 1.00. Weight about 62 lbs. per cu. ft. Grain mostly straight; sometimes wavy or roey. Texture fine. Wood fairly easy to work, finishes smoothly, takes a high polish, is very tough, strong, and durable. Specimens that have not been surfaced usually have a harsh feel.

Growth rings: Indistinct or occasionally distinct; often doubtful; when present due to limiting line of parenchyma and occasionally, also, to narrow poreless zones.

Parenchyma: About pores and extending wing-like from them, often confluent in fine irregular wavy lines, more or less ulmiform; varying in distinctness from barely visible to quite distinct; visible, but not prominent, on longitudinal surfaces, being lighter than background.

Pores: Small to medium, not always distinct without lens except on account of parenchyma; numerous; usually well distributed; solitary or subdivided radially.

Vessel lines: Readily visible, but not conspicuous; due to parenchyma sheath, which is of lighter color than background.

Vessel contents: Some gum deposits and occasionally white substance present.

Rays: Very fine, but visible, on cross section; invisible on tangential; distinct on radial surface.

Ripple marks: Absent.

Gum ducts: Vertical ducts resulting from injury observed in one specimen (Yale No. 568) which has the color but not the typical structure of *Peltogyne.*

Remarks: There is considerable variation in the size, abundance, and arrangement of the pores in different specimens of purpleheart and it is not unlikely that more than one genus is represented. Usually, however, this variation is not much greater than is occasionally noted in different parts of the same piece. The evidence at hand does not seem to justify referring any of these woods to *Copaifera,* as is so frequently done. One specimen (Yale No. 3031A) from the Guianas bears considerable resemblance to *Hymenaea.* A very distinct kind of purpleheart from Brazil, known as "itapicurú" or "guarabú amarello," is yellow when freshly cut, but eventually turns purple on the surface; it has ripple marks. (For further description, see below.)

Material: Yale Nos. 685, 2089, 3183, 3279*, 3309, 3387, 3563, 4256, 4282, 4450, 4715 (Braz.); 5391 (Fr. G.); 4172, 4194 (Sur.); 4204, 5115,

5116 (B. G.); 1436 (Mart.); 568 (Trin.); 6344* (Venez.); 1541*, 1558, 1564 (Col.); 4340 (Pan.); 4401 (Mex.). Asterisk indicates botanical material.

"ITAPICURÚ"

This is a common tree in the States of Bahia and Espirito Santo, Brazil, where it occurs in almost pure stands over small areas in the transitional zone between the chaparral and rain forests. In these situations it is a slender tree up to 20 inches in diameter and from 60 to 75 feet high. It also extends along the streams into the rain forest belt and in these favorable conditions attains a height of 100 feet with a well-formed bole sometimes three feet in diameter and clear of branches for 60 feet. The timber is used in Bahia for all kinds of durable construction, but is rarely met with in the markets. In Espirito Santo it is considered one of the best woods of the region for railway ties.

The identity of "itapicurú" has not been determined. The leaves are compound, with two pairs of smooth leathery leaflets. The bark is thick, finely corrugated, and of a gray color. The wood is of a greenish-sulphur color when fresh, but turns purple on the surface after exposure, as in the case of *Peltogyne*.

THE WOOD

(Unknown) *Itapicurú.*

Common names: Itapicurú, itapicurú amarello, guarabú amarello (Braz.).

General properties: Color deep dull yellow, becoming purple on the surface as result of exposure; sometimes with blackish streaks. Sapwood thick, white, sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) 1.10. Weight about 68 lbs. per cu. ft. Grain straight to somewhat roey. Texture medium. Wood fairly easy to work, finishes smoothly, is very strong and durable.

Growth rings: Distinct, due to concentric lines or bands of parenchyma.

Parenchyma: About pores and pore groups, but usually not confluent; also in concentric lines, varying from very narrow and indistinct to rather broad and distinct, rather distantly spaced.

Pores: Small, but very distinct on account of parenchyma about them; occurring singly or in small groups, not very numerous; distribution fairly regular, though narrow poreless zones occur.

Vessel lines: Very distinct on account of parenchyma; mostly long lines.

Vessel contents: Some tyloses and some white substance noted.

Rays: Very fine; invisible on cross section, faintly visible on tangential, fine, but distinct, on radial, when they appear darker than the background, especially on freshly exposed surface.

Ripple marks: Present; rather irregular and wavy; faintly visible without lens; all elements storied; number per inch, 75 to 80.

Gum ducts: None observed.

Remarks: Dark-colored specimens superficially resemble purpleheart (*Peltogyne*), but structure is different.

Material: Yale Nos. 3185, 3252 (with leaves), 3549, 4236, 4292 (Braz.).

EPERUA

The eight or nine known species of this genus are almost entirely confined to the Guianas and northern Brazil. *Eperua purpurea* Benth. is said to be one of the tallest and most ornamental trees of the forest known as "catingas." The Indians of the Rio Negro and Rio Uaupes call it "jebarú" or "cupaúba-rana," and use the very sticky sap for bird lime, and the red bark for making musical instruments called "yuruparis" (*Pflanzenfamilien*, 3:3:141).

The genus is best known in British Guiana, where the trees are called wallaba. Anderson[88] says:

> Of the several kinds of this wood, the two principally used are "soft" wallaba (*Eperua falcata* Aubl.), and "ituri" wallaba (*E. Jenmani* Oliver). The heartwood of both of these species is of a very lasting nature and is in great request for posts of all sizes and also for making shingles, palings, vat staves, etc. It is a heavy, hard wood (sp. gr. 0.98), with a coarse but more or less even grain. It splits readily, is very resinous, and has an unpleasant smell which disappears after a sufficiently long exposure. The ituri wallaba is similar in character to the soft variety, but is not as abundant. Another kind called the "bimiti" wallaba[89] is only used for firewood and as all three of these varieties burn well, they are very suitable and much used for fuel. On account of its admitted durability, many uses, and great abundance, wallaba, if sufficiently advertised, should sooner or later, as the wood becomes better known, form one of, if not the most, important export timbers of this colony.
>
> Wallaba trees of various kinds are to be found growing in more or less quantities throughout the greater part of the forest lands of the colony. The most extensive areas of wallaba forests, or forests in which soft and ituri wallaba trees predominate, are situated in the central and eastern parts of the colony on the slightly elevated and hilly lands of white loose sand, which these species most favor. Smaller areas also occur in certain parts of the northwestern district.
>
> The combined results of sectional surveys made in wallaba forests at 30 different localities in various parts of the colony indicate that these forests

[88] Anderson, C. W.: *General report on the forests of the easily accessible districts of the colony*, Georgetown, 1912, pp. 30-32.

[89] Said to be *E. Schomburgkiana* Benth. "Bimiti" means humming-bird; "ituri," baboon.

contain on an average of 169.5 trees to the acre, having a minimum girth of 18 inches and that 42.8 per cent of the trees consist of two species of wallaba intermixed at places and occurring in the following proportions: Soft wallaba, having an average girth of 44 inches, 34.4 per cent; ituri wallaba, having an average girth of 42.4 inches, 8.4 per cent. The ituri is not so widely distributed as the soft wallaba, occurring only in certain localities. . . . Greenheart is seldom, if ever, found growing in the "wallaba forests," although wallaba grows more or less abundantly in the "greenheart forests." In the forests of the swamp lands, wallaba is usually confined to the places where the soil is more or less of a sandy nature. In addition to the soft and ituri, several other species of wallaba are found to grow in the forests on the low lands. One of these is known by the name of "bimiti wallaba," but other kinds also appear to be called by this name.[90]

THE WOOD

Eperua falcata Aubl. *Wallaba.*

Common names: Wallaba, soft wallaba (B. G.); bylhout, bijlhout, woapa, wouapa, walaba (Sur.); wapa, wapa huileux, wapa gras, eperu (Fr. G.); apa, apazeiro, espadeira, wapa patouvé (Braz.); palo machete (Venez.); wallabaholz (Germ.). VARIOUS SPECIES: Bimiti wallaba, ituri or itoori wallaba (B. G.); itoerie ballaba, bierie hoedoe, bili hoedoe, roode walaba (Sur.); wapa blanc, wapa courbaril ?, pois sabre (Fr. G.); gebarú, jebarú, jebarú-rana, bainha de espada, cupaúba-rana (Braz.).

General properties: Color dull reddish-brown, deepening upon exposure and becoming somewhat purplish; streaked with oil or gum which exudes in the surface. Sapwood dingy white, rather sharply defined; has oily streaks.

Odor unpleasant when fresh; mildly rancid in thoroughly dry specimens. Taste not pronounced.

Hard and heavy. Sp. gr. (air-dry) 0.90. Weight about 56 lbs. per cu. ft. Grain straight. Texture medium to coarse. Wood easy to cut and split, finishes smoothly, but difficult to polish on account of gummy exudations; is highly durable; feels sticky.

Growth rings: Distinct or fairly so; limited by parenchyma and often by compact row of gum ducts.

Parenchyma: In concentric lines rather widely spaced and apparently limiting growth rings; often associated with gum ducts; fairly distinct; sparingly developed about pores.

Pores: Large and distinct; rather few and scattered; occurring singly or occasionally subdivided; open.

Vessel lines: Long, straight, coarse; distinct, but not conspicuous; segments visible without lens.

Vessel contents: Some gum deposits; tyloses apparently absent.

[90] "The 'water wallaba' or 'sara-bebe,' a tree commonly found along the rivers and creeks of the colony, is not a species of *Eperua*, but is *Macrolobium Vuapa* J. T. Gmel."

Rays: Rather coarse; readily visible on cross section; faintly visible on tangential, rather high and very distinct on radial surface, producing silver grain.

Ripple marks: Absent.

Gum ducts: Very common; occurring in single compact tangential or concentric rows; the largest are about the size of the smaller vessels and are likely to be mistaken for them, but have less distinct and regular outlines; filled with sticky red gum that exudes in quantity and discolors the wood.

Remarks: Specimens of the "ituri" variety, *E. Jenmani,* supplied by the British Guiana Department of Lands and Mines (No. 143A, Yale No. 5119), are of the same general character, but are somewhat harder, heavier, and finer-textured throughout. The gum ducts are smaller and fewer, and the rays only half as distinct as in the "soft" variety. The same is true of a specimen of "bylhout" from Surinam (Yale No. 4162).

Material: Yale Nos. 578, 3049, 4206, 5120 (B. G.); 4199 (Sur.); 5402 (Fr. G.); 4077 (Trin.).

DIALIUM

This genus consists of about 25 species of trees, of which all but one are native to the tropics of the Old World. The only species in tropical America is *Dialium divaricatum* Vahl., a large tree occurring in the forests of eastern Brazil, where it is known as "jutahy peba" or "jetahy preta" and "itú"; in Colombia, there called "granadillo"; and in Central America, where the native name of "tamarindo" is given to it because of its tamarind-like fruit. The leaves are imparipinnate with five to seven alternate, ovate-lanceolate leaflets one to three inches long and from half an inch to an inch wide. The bark is smooth and is used for medicinal purposes. The pulp surrounding the seeds is edible.

The dark reddish-brown wood is very strong and durable and is used for heavy construction on land and in the water, and makes excellent posts, props, and piling. It is also suited for tool handles, implements, spokes, and railway ties. It is too hard and has not enough figure to make it suitable for furniture.

THE WOOD

Dialium divaricatum Vahl *Jutahy peba.*

Common names: Jutahy peba, jetahy preta, itú (Braz.); granadillo (Col.); tamarindo, tamarindo del monte, tamarindo prieto (C. A.).

General properties: Color uniform brown or reddish-brown, deepening upon exposure, rather dull. Sapwood thick, nearly white; line of demarcation not very sharp.

Odor and taste absent or not distinctive.

Dense, hard, and heavy. Sp. gr. (air-dry) 0.90. Weight about 56 lbs. per cu. ft. Grain somewhat interwoven. Texture rather fine. Not easy to work,

finishes smoothly, is very tough, strong, and durable. Sapwood is less difficult to work than the heart.

Growth rings: Absent.

Parenchyma: In very numerous fine, closely, but not always uniformly, spaced, concentric lines, mostly independent of the pores; distinct to indistinct.

Pores: Small; sometimes barely visible without lens; scattered; occurring singly or subdivided; mostly open. Considerable variation in size and number of pores in different specimens.

Vessel lines: Usually fine and inconspicuous.

Vessel contents: White substance occasionally present.

Rays: Not visible without lens on cross and radial sections; visible, but very fine and inconspicuous, on radial surface.

Ripple marks: Present; faintly visible; regular to very irregular; all elements storied; number per inch, 100 to 105.

Gum ducts: None observed.

Remarks: The name "jutahy," though commonly applied in Brazil to various species of *Hymenaea,* is extended to include a number of other woods. There are two or three kinds of "jutahy peba." One of these, of unknown identity, is a deep rose-colored wood with medium-sized pores in conspicuous diamond-shaped patches of parenchyma, and with prominent vessel lines.

Material: Yale Nos. 3191, 3258, 3503, 4246 (Braz.); 3696*, 3698*, 3710 (Guat.-Hond.); 1576* (Col.); 6347* (Venez.). Asterisk indicates botanical material.

APULEIA

There are three or four species of this genus in eastern and southern Brazil and Argentina. *Apuleia ferrea* Mart., with a range from Bahia to Rio Grande do Sul, is said by Correa[91] to have an extremely dense wood, specific gravity 1.243, used for civil and naval construction, hydraulic and exposed construction, sleepers, bridges, house posts, and carpentry; the bark is used for tanning. It is called "páo ferro," a name applied to various other Brazilian woods.

The species to which reference is most commonly made is *Apuleia praecox* Mart. It is a common tree of the forests of the Alta Paraná region, occurring as scattered individuals, often 100 feet high with a bole clear of branches for 50 to 60 feet, and sometimes four feet in diameter. The bark is thin and tough, and flakes off in long strips as in shagbark hickory (*Carya ovata*), leaving a spotted or pitted surface that is highly characteristic. On this account the Indians call the tree "ibirá-peré," meaning spotted or pitted tree. Brazilians living in Argentina call it "madera manchada." The strong and durable wood is used

[91] Correa, M. Pio: *Flora do Brazil,* Rio de Janeiro, 1909, p. 58.

for heavy construction, flooring, shafts of vehicles, and posts. The bark is rich in tannin.

The same or a closely related species in Bahia, where it is known as "jutahy amarello," attains a height of 125 feet, diameters of three to four feet, with clear lengths of 50 feet. The wood is in good repute for its toughness and durability. In the Yale collections are specimens of mine timbers of this wood (Nos. 3487, 3488) which had been in use in Pedras Pretas, Bahia, for twenty years, and although badly decayed still retain considerable strength.

THE WOOD

Apuleia praecox Mart. *Iberá-peré.*

Common names: Iberá-peré, yberá-peré, iberá-piapuña, grapiapuña, madera manchada (Arg.); grapiapunha, grapiapunha branca, jutahy (jitahy, jatahy) amarello, garapa amarella (Braz.).

General properties: Color lustrous golden yellow or yellowish-brown; may acquire a reddish tinge upon exposure. Sapwood rather thin, white, sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.80 to 0.95. Weight 50 to 60 lbs. per cu. ft. Grain mostly straight; may be roey. Texture fine and uniform. Wood fairly easy to work; takes high polish; is strong and elastic, durable.

Growth rings: Present, but not always distinct without lens; usually limited by fine lines of parenchyma.

Parenchyma: In very fine, but visible, wavy lines extending from pores and sometimes independent of them, producing an effect varying from fine network to ulmiform, with fine pattern on tangential surface; concentric lines usually limit growth rings.

Pores: Very small, barely visible without lens; numerous; well distributed; sometimes subdivided radially; open. Occasionally narrow poreless zones present.

Vessel lines: Very numerous fine veins; inconspicuous.

Vessel deposits: Occasional gummy and white deposits noted.

Rays: Very fine, invisible without lens on cross and tangential sections. Visible, but fine and inconspicuous, on radial, where they are somewhat lighter than background.

Ripple marks: Present; all elements storied; regular; visible without lens, but more distinct with it; number per inch, 85 to 105.

Material: Yale Nos. 1721* ?, 1734, 4130 (Arg.); 2497, 3368, 3487, 3488, 3541, 3581*, 4680* (Braz.). Asterisk indicates botanical material.

DICORYNIA

Of the two species of this genus, much the better known is *Dicorynia paraënsis* Benth. of the lower Amazon region and the Guianas. It is

most abundant and important in French Guiana where it grows in small groups in the forest and attains a height of 100 feet or more, with a long clear bole nearly five feet in diameter and somewhat buttressed. The branches are coarse and gnarly; the outer bark of the trunk flakes off in small scales; the leaves are imparipinnate with seven or nine small leathery leaflets; the flowers are small, white, and in terminal panicles; the pods are oval, flattened, leathery, winged along one side, about three inches long and half as wide, and containing only one or two seeds.

The local name of the tree in French Guiana is "angélique." Although two kinds are recognized, namely the "angélique rouge" or "angélique franc," and the "angélique gris," they are considered identical from a botanical standpoint. The "angelique gris" is a comparatively rare tree and has a lighter-colored and less highly esteemed wood than the other kind, which is to be had in quantity and is considered the equal of oak and teak. The wood is extensively used for all sorts of construction, whether indoors, in the open, or in the water, and for carpentry, joinery, cabinetwork, interior trim, as well as for piling, posts, railway ties, and charcoal.

The tree also occurs, though less commonly, in Surinam, where it is known as "basra lokus." The good quality of the wood is recognized, but its uses are limited because of the small supply of the timber. A specimen of this wood (Yale No. 4957) which Mr. Gonggrijp, the Forester of Surinam, had exposed to the attack of the shipworms for eight months, shows numerous small teredo holes penetrating to a depth rarely more than one-half inch. Mr. Gonggrijp attributes this relatively high immunity to the attacks of the *Neo-teredo*, to the presence in the wood of silica particles. He also believes that this timber will prove highly valuable in harbor works because of its freedom from decay, since the heartwood of logs that had lain on the ground in the moist forest for fourteen years was found to be perfectly sound.

THE WOOD

Dicorynia paraënsis Benth. *Angélique.*

Common names: Angélique, angélique rouge, angélique franc, angélique gris (Fr. G.); basra lokus, bastard locus, kabakally, bois angélique (Sur.); angelica do Pará (Braz.).

General properties: Color dull olive-brown, often with reddish patches, with a fine wavy pattern of deeper-colored parenchyma on the tangential surface. Sapwood reddish-white; rather sharply defined.

Odor suggests vinegar. Taste not distinctive.

Rather hard and heavy. Sp. gr. (air-dry) 0.75 to 0.90. Weight 47 to 56 lbs. per cu. ft. Grain usually straight. Texture medium. Wood easy to work, finishes smoothly, but does not take a high polish, holds its place, is not

inclined to warp and check badly, is highly resistant to decay and to insect attack and moderately so to marine borers.

Growth rings: Apparently absent.

Parenchyma: Abundantly developed; in numerous, wavy, concentric, sometimes anastamosing bands which are from one-fifth to nearly equal the width of the intervening fiber layers; producing distinct pattern on tangential surface, but not very distinct on the cross section.

Pores: Few; large and distinct; irregularly scattered; usually single and oval; occasionally in rather long ladder-like radial rows; mostly open.

Vessel lines: Usually very distinct, as lighter or darker veins; segments readily visible without lens.

Vessel contents: Dark gum common; white substance abundant in one specimen (Yale No. 5366).

Rays: Very fine; invisible on cross section; not individually visible on tangential; low and uniform, but distinct, on the radial surface, appearing darker than background.

Ripple marks: Present; very distinct; fairly regular; all elements storied; number per inch, 55 to 60.

Gum ducts: None observed.

Remarks: For detailed description of minute anatomy see Janssonius, H. H.: Mikrographie einiger technisch wichtigen Holzarten aus Surinam, *Verh. d. Kon. Akad. v. Wetenschappen te Amsterdam* (2d sec.), 18: 2: 35-40, Feb., 1914.

Material: Yale Nos. 5365, 5366, 5369 (Bertin's Nos. 3003, 3004, 3007) (Fr. G.); 4169, 4957 (Sur.).

GLEDITSCHIA (GLEDITSIA)

The 18 species of this genus occur in China, Japan, Formosa, Philippine Islands, west tropical Africa, eastern North America, and the south central portions of South America. Some of the trees attain large size, but more often are rather low and spreading and well adapted for ornamental purposes. They are usually armed with long, sharp spines, which may be simple or branched. The leaves are simply or doubly pinnate (both forms common on the same tree) and the leaflets are small. There are three species in the United States, the best known being the honey locust, *G. triacanthos* L.

There is one species, *G. amorphoides* (Gris.) Taub., in northern Argentina, Bolivia, and southern Brazil. It rarely attains a height exceeding 50 feet, though trunk diameters of from 24 to 32 inches are not uncommon. It is typically very spiny, though there is a form in Formosa, Argentina, that is usually unarmed. The hard, tough, and durable wood is used locally for construction, carpentry, fence posts, and especially for fuel. The sapwood is subject to attack by insects. The pods, called "cambá-nambí" (negro ears), and the bark contain a con-

siderable quantity of saponin and are employed by the Indians as a substitute for soap.

THE WOOD

Gleditschia amorphoides (Gris.) Taub. *Espina Corona.*

Common names: Caá-nambí, cambá-nambí, espina corona, espina de corona, espina de corona Cristi, espinillo, e. amarillo, quillay, sucará, yuguazú (Arg.); coronilla, espinho de Cristo, espinilho (Braz.).

General properties: Color reddish or rosy brown, often with lighter streaks; luster low. Sapwood thick, yellowish, rather sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. 0.86 to 0.95 (Castro). Weight 54 to 59 lbs. per cu. ft. Grain somewhat roey. Texture medium. Wood fairly easy to work, strong, tough, and elastic, finishes smoothly; heartwood durable, but sapwood is not resistant to decay or insect attack.

Growth rings: Not always clearly defined; sometimes distinct due to parenchyma.

Parenchyma: Abundantly developed about the pores and connecting them into wavy, ulmiform pattern; also in concentric lines apparently limiting seasonal growths.

Pores: Small; their distinctness due to parenchyma about them; not very numerous; well distributed; occurring singly, subdivided, or grouped, often in diagonal arrangement; mostly joined into irregular chains by parenchyma.

Vessel lines: Very distinct in proper light, due to parenchyma sheaths which appear considerably lighter than background.

Vessel contents: Some gum deposits noted.

Rays: Very fine; faintly visible on cross section, invisible on tangential; low, but distinct in proper light on radial surface where they appear lighter than background.

Ripple marks: Absent.

Gum ducts: None observed.

Material: Yale Nos. 991, 1049*, 1123, 1691*, 3980, 6219 (Arg.). Asterisk indicates botanical material.

HAEMATOXYLON (HAEMATOXYLUM)

This genus, well known as an important source of dyewoods, consists of two tropical American species of low trees, one yielding the logwood of commerce, the other the brasilette or one of the brazilwoods.

LOGWOOD

The logwood tree, *Haematoxylon campechianum* L., is rarely 50 feet high and two feet in diameter, usually much smaller, with short, gnarled and fluted trunk and branches that are covered with a rough, grayish or

brownish bark. The leaves are pinnate with three or four pairs of somewhat wedge-shaped leaflets, varying in length from half an inch to an inch and about half as wide as long. The clustered flowers are small, yellow, and ill-scented, and the pods are thin and flat, suggesting those of the black locust (*Robinia pseudacacia*).

The tree is indigenous chiefly to the mainland of tropical America, being most abundant in southern Mexico (Tabasco, Campeche, and Yucatan) and throughout Central America, and fairly common in Colombia, Venezuela, and the Guianas. It seems to be native in Santo Domingo, as the wood is said to have been exported from there to Spain in the latter part of the sixteenth century. The early center of the industry, however, was in southern Mexico and it is stated that when Grandmont captured Campeche he burned more than a million logs stored there.[92] Large quantities of the timber were brought to Jamaica in sloops for reshipment to Europe. About 1715 Dr. Barham introduced the seeds into Jamacia from Honduras and the planting since then has been so regular and extensive that Jamaica now produces about one-fifth of the world's supply of logwood.

The early attempts to use logwood dyes in England were not successful, as there was no method known at that time for making the colors permanent, and in 1581 the importation and use of logwood was prohibited by a law which was not repealed for nearly a hundred years, long after chemists had learned how to make a fast dye out of the extract. During the period of its prohibition the wood was clandestinely imported and used under the name of blackwood and other aliases.

Only the heart portion of logwood is useful and in consequence the thin white sapwood is hewed off in the forest. In Mexico the tree grows best in hot marshy places, teeming with mosquitoes, and the work of cutting and hewing the hard wood is particularly arduous. In many localities the country is flooded for part of the year and the wood can be removed in boats. In Haiti the tree finds its best development in the interior valleys and moist coves in the lower slopes of the mountains all over the island. The wood is commonly transported on the backs of burros to the coast towns and sold to the native dealers for export. The logs can be stored in the open for years without serious deterioration.

The wood entering the New York market is usually in the form of irregular logs and sticks about three feet long. At the dyeworks it is reduced mechanically to small bits and the dye extracted by boiling in water. The peculiar coloring principal, called haematoxylin, forms an

92 Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.*, 23:2: 419 (1922).

orange-red solution with boiling water, becoming yellowish as it cools, recovering its former hue if heated, and if left to itself it finally turns black. Various shades and colors can be obtained by the use of proper mordants, but the greatest consumption of logwood is for blacks, which are obtained by alum and iron bases, and of any desired intensity. In addition to dyes it is also used in the manufacture of inks and to a minor extent for medicinal purposes.

THE WOOD

Haematoxylon campechianum L. *Logwood.*

Common names: Logwood, campeachy or campechy wood, campetch, peachwood, poachwood, blackwood, blockwood (Eng.); Campecheholz, Campeschenholz, blauholz, blutholz, allerheiligenholz, blankholz (Germ.); bois noir, bois bleu, bois de Campêche, bois de sang, bois sanglant, bois de la Jamaïque, bois de Nicaragua, campêche, campêche carmen, campêche rouge, coeur rouge (Fr.); campeggio, legno di campeggio, legno azzurro, legno nero (Ital.); palo de Campeche, palo de sangre, palo azul, palo de tinta, tinto (Span.); páo sanguinho (Port.).

General properties: Color bright red, becoming darker upon exposure; may have dark streaks. Sapwood thin, white or yellowish, sharply defined.

Odor of violets when fresh; may be absent in dry wood. Taste sweetish.

Very hard and heavy. Sp. gr. (air-dry) about 1.00. Weight about 62 lbs. per cu. ft. Grain irregular and more or less interwoven. Texture fine. Wood hard to cut, finishes smoothly, takes a high polish, is strong, but rather brittle, is highly durable.

Growth rings: Fairly distinct; due to fine line of parenchyma.

Parenchyma: About pores and in wing-like processes which may join into short or long wavy, tangential or concentric lines or bands; sometimes also in fine lines independent of pores and apparently limiting seasonal growths; usually very distinct.

Pores: Small, but visible; occurring singly or subdivided; not crowded; no definite arrangement, except as linked tangentially by parenchyma.

Vessel lines: Fine, but fairly distinct.

Vessel contents: Gum deposits abundant; some white substance observed.

Rays: Fine, but visible, on cross section; invisible on tangential; fairly distinct on radial; not storied.

Ripple marks: Absent or very poorly defined.

Gum ducts: None observed.

Remarks: The coloring principle, which is soluble in water, gives with lime, baryta and stannic chloride, a blue precipitate, while that of brazilwood or brazilette is red.

Material: Yale Nos. 2124 (Cuba); 4857 (Haiti); 2699 (P. R.); 2160 (Curaçao).

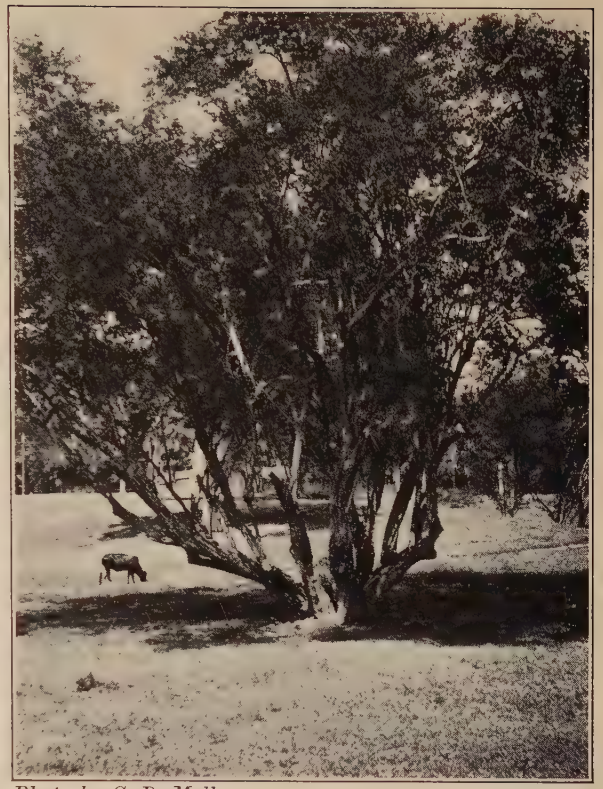


Photo by C. D. Mell.

Old Logwood Tree in Trinidad.

(*Haematoxylon campeachianum.*)

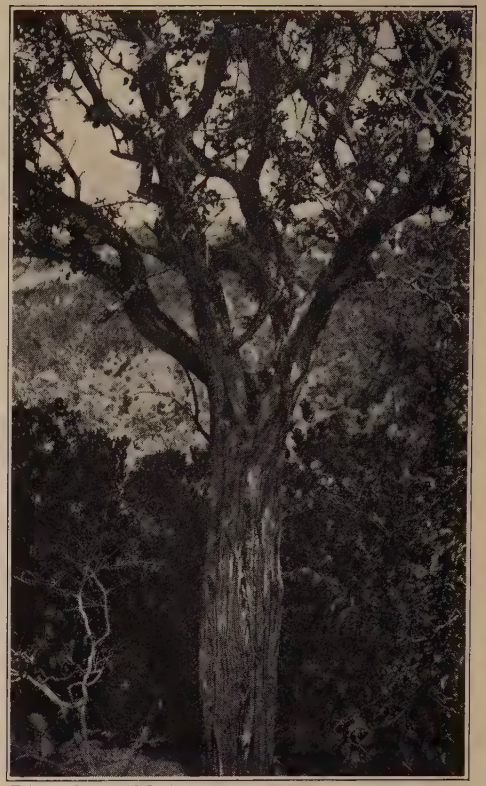


Photo by H. M. Curran.

Brazilette Tree on Venezuelan Coast.

(*Haematoxylon Brasiletto.*)

PLATE XXVII

BRAZILETTE

Brazilette is the name commonly applied in the trade to the heartwood of *Haematoxylon Brasiletto* Karst. (= *H. boreale* S. Wats.), a tree similar in habit to the logwood and often confused with it. It occurs in Mexico, Central America, northern South America, and the West Indies, and is extensively used as a source of dyes and locally for medicinal purposes. In the trade it is usually classed with brazilwood (*Caesalpinia echinata*) and supplies "brasilin" and not the "haematin" crystals of genuine logwood.

The wood from Nicaragua is known locally as "brasil" and in the trade as Nicaragua wood or "hypernic," the latter term coined to indicate a superlative quality of the wood from that country, but subsequently applied rather indiscriminately to any red dyewood or dyewood extract. The wood was first cut and shipped to England from the region of the Gulf of Nicaragua, opposite to Providence Island, said to be the only place the species is found on the Atlantic side of that country, although it grows abundantly on the Pacific side. It was sold at one time in England for $140 a ton, or double the price of logwood then prevailing. The wood dyes a bright or so-called fancy red that is very beautiful. The botanical source of this material is often mistakenly referred to as a species of *Caesalpinia.*

As early as 1848 large quantities of this wood were cut and shipped to Havre and Hamburg in schooner cargoes from Mazatlan, Mexico. As stocks became scarce in that region the cutting area shifted farther north, and in more recent years Altola and Paixtla have been centers of the industry. During the war, when shipping by water became difficult, thousands of tons of brazilwood were shipped by rail to users of dyewood in eastern United States, and this method of transportation will probably be continued.

While this wood is becoming scarce near the coast, where it has been exploited for more than 75 years, large quantities are still available along the upper reaches of the numerous streams rising in the Sierras. Cutting starts in October or November and continues until the end of June. The wood is carried on the backs of mules from the interior hills over a country without roads to the railroad which follows the coast from Mazatlan to Guaymas. Just how far north along the western slopes of the mountains this species is found in commercial quantities is not a matter of record, but it is safe to assume that it grows near the northern limit of the State of Sinaloa.

In northern Mexico the brazilette is usually called "brasil" or "palo de brasil," but the names "palo de tinta" and "palo de Campeche" are

applied in the south; in Oaxaca it is known also as "azulillo." In Colombia, where the type of the species was collected, it is called "brasiletto"; in Venezuela, "brasil."

The wood appears to be intermediate between *Haematoxylon campechianum* and *Caesalpina echinata*. The color of the fresh heart is a rich orange, turning to dark red upon exposure. The shape of the trunk is the same as that of logwood; the development of parenchyma is much the same, though showing more tendency to the formation of concentric bands including the pores, while ripple marks, which do not include most of the rays, are somewhat better developed than in the other species, though never very distinct.

Material: Yale Nos. 2145 (Curaçao); 4980 (Mazatlan, Mex.); 5233 (Nic.); 5069 (S. D.).

CAESALPINIA

This genus consists of over 125 species of shrubs and trees widely distributed throughout the tropical and sub-tropical regions of the world. Some of the plants are cultivated for decorative purposes. Although certain of the trees are large enough to produce lumber, most of them are small and are of chief value for the dyestuffs and tannins supplied by the wood, fruit, and bark. The commercial woods are of two general classes, namely, the orange or red and the dark brown.

The most widely distributed member of the first group is *Caesalpinia crista* L., a small misshapen prickly tree or shrub occurring on tropical and sub-tropical coasts of both hemispheres and sometimes forming impenetrable thickets of considerable extent. The large and extremely hard seeds, known as nicker nuts, are rich in oil and contain a bitter principle reputed to have medicinal virtue. The wood is said to be similar in its structure and properties to that of *C. echinata* of Brazil and is sometimes confused with it. The common names are: Brasil cojones de gato, jabilla, haba de San Antonio, guacolote, taray (Mex.); guacalote prieto, brasilette colorado, palo fernambuco (Cuba); mato azul, mato de playo (P. R.); gray nickers (St. Thom.); nickers (St. Croix); horse-eye, quasha (Grenada); canique gris, ceil de chat (Guad.); yeux de chat (Mart.).

BRAZILWOOD

The best known representative of the first group is the brazilwood or Pernambuco wood of commerce, important as a source of dyes and considered the only satisfactory material for making violin bows. This is supposed to have come originally from *Caesalpinia brasiliensis* L., but this may be a mistake, since the only Brazilian species known to produce it is *C. echinata* Lam. of the coast forests of eastern Brazil from the

vicinity of Bahia southward. The forest-grown tree attains a height of more than 100 feet, with a slender symmetrical bole upward of three feet in diameter, clear of branches for 50 or 60 feet, and covered with a thin, rough bark. The leaves are doubly compound, with many small leaflets somewhat like those of the honey locust (*Gleditsia*).

The early demand for this wood was so great that the business was made a royal monopoly, and private exploitation was strictly prohibited. The methods of exploitation were wasteful and without any regard to the future of the forest. It is said that many of the early planters surreptitiously felled the trees on their estates and used the timber for fuel in order to avoid the arbitrary regulations of the government agents. Such procedure resulted in the extermination, almost, of this tree in the accessible regions along the coast, and the continuance of the industry has been entirely dependent on extending the operations into regions of increasingly difficult access, since the tree rarely occurs in the second growth.

The wood which now enters the market is in the form of short logs, often small and irregular, with all of the sapwood hewed off, since it is white and without value. The lots are usually picked over in the search for straight-grained, fine-textured pieces for the making of violin bows. In the making of dyestuffs the wood is ground into very fine particles, as otherwise it will not give up the color readily in water. The treatment is similar to that given logwood (*Haematoxylon*), but the oxidizing process need not be continued as long and the concentration of the liquid can be secured more quickly because of the higher temperature that can be used. The dyes are similar to those obtained from cochineal and alizarin, and are used chiefly in dying and printing calico. By the use of mordants various colors, such as red, brown, violet, and black, are obtainable. Quercitron is frequently used in mixture in the manufacture of the cheaper grades of dyes. Beautiful shades can be obtained from the decoctions for use chiefly in tinting paper.

As in the case of other dyewoods, the demand for brazilwood has been very materially reduced by the competition of the coal-tar dyes, but nevertheless these woods continue to be a factor in the trade, and in emergencies, such as occasioned by the recent war, quickly assume their old-time importance.

The name brazil, "brasil," or "brésil" was originally applied to an East Indian wood that was being used as a commercial source of dyes as early as the twelfth century. This was probably *Caesalpinia Sappan* L., now known as Indian redwood, "sappan," and false sandalwood. When, about 1500, an abundance of similar wood was discovered in eastern South America, the region producing it was named Brazil. Since

brazilwood of commerce may or may not come from Brazil and since this name is applied not only to various species of *Caesalpinia* but also to *Haematoxylon* and other genera, there is naturally considerable confusion in the trade as to what brazilwood is. The name, in order to have definite meaning, must be accompanied by some specific term, usually referring to the source of origin. The name "hypernic," originally applied to a dyewood (*H. Brasiletto*) from Nicaragua, has lost its specific meaning and is now practically synonymous with brazilwood.

THE WOOD

Caesalpinia echinata Lam. *Brazilwood.*

Common names: Brazilwood, Pernambuco, Fernambuco, Pará, or Bahia wood, peachwood (Trade); Fernambukholz, Brasilienholz (Germ.); brésil (Fr.); palo brasil (Sp.); legno del Brasile, legno rosso, legno di Santa Marta, fernambucco, pernambucco, verzino (Ital.); páo brasil, ibiri pitanga, ymirá piranga (Braz.).

General properties: Color bright orange, fairly uniform except for occasional darker striping; lustrous; turns deep red or reddish-brown upon exposure. Sapwood thin; white or yellowish.

Odor and taste absent or not distinctive.

Very hard, heavy, compact. Sp. gr. (air-dry) 1.24; (oven-dry) 1.21. Weight (air-dry), about 78 lbs. per cu. ft. Grain variable from straight to more or less interwoven. Texture fine. Wood takes a high polish, is strong and resilient, very durable.

Growth rings: Usually present, but not always distinct, even with lens; limited by fine line of parenchyma.

Parenchyma: Inconspicuous about pores, sometimes connecting them irregularly; also limiting growth rings and sometimes in two or more very fine and often poorly defined concentric lines within each ring, mostly independent of the pores; produces faint patterns on tangential surface.

Pores: Very small, but visible on account of narrow halo of parenchyma; numerous to abundant, fairly well distributed; mostly single, but often in radial groups of two to five, sometimes linked by parenchyma into short tangential or diagonal rows.

Vessel lines: Very fine, numerous, inconspicuous.

Vessel contents: Sometimes reddish gum deposits occur.

Rays: Very fine; invisible or at limit of vision on cross and tangential sections; visible, but inconspicuous, on radial, where they appear darker than background.

Ripple marks: Present; all elements storied; rather irregular; varying from faintly visible without lens to fairly distinct; about 90 per inch.

Gum ducts: None observed.

Remarks: Closely resembles *C. Sappan* in structure, color, and other properties; also much like a specimen of brazil from Curaçao (Yale No. 2804), and a Cuban specimen (Yale No. 781) of "brasilette colorado," believed to

be *C. Rugeliana* Urb. A wagon wheel spoke (Yale No. 2044) from Havana is apparently the same species. A wood from Santo Domingo (Yale No. 4078) has a similar structure and color, but is not nearly so hard and has a pronounced spicy fragrance and a sweetish taste.

Material: Yale Nos. 1686, 1800*, 1801, 3106, 4444 (Braz.). Asterisk indicates botanical material.

"DIVI-DIVI"

To the group of trees with dark brown wood belongs the "divi-divi," *Caesalpinia coriaria* Willd., an unarmed shrub, or a poorly formed tree 15 to 30 feet high, with a short bole sometimes 16 inches in diameter, common in open semi-arid country, preferably on the dry outskirts of the tide belt along the coasts of southern Mexico, Central America, northern South America, and the West Indies. Its natural range has been extended by planting and it is now cultivated in Jamaica and to a minor extent elsewhere in tropical America, and in Java, Ceylon, India, and various parts of tropical Africa. The value of this plant is not in its wood, but in its curled or S-shaped pods which are an important source of tannin. These pods are filled with a yellowish powdery substance surrounding the few seeds and this powder contains as much as 50 per cent of tannin of exceptional qualities. A full-grown tree will produce about 100 pounds of pods annually. Most of the "divi-divi" used in the United States comes from Colombia and Venezuela. Considerable quantities are used locally in various tropical countries for tanning purposes and also for making a black dye. It is said that the reddish-brown, flinty-hard wood is sometimes used as a source of a red dye. The common names of this tree are: Divi-divi, dibi-dibi (Trade); cascalote, nacascolotl, nacascul (Mex.); nacascol (C. R., Salv.); nacascol, nacascolo (Nic.); nacascolote (Guat.); agallo (Pan.); divi-divi, libi-dibi (Col.); divi-divi, guatapán, guatapanare (Venez.); guatapaná, divi-divi, dibi-dibi (Cuba, S. D.); guastapaná (S. D.). (Plate XI.)

"GUAYACAN," "PAO FERRO," AND PARTRIDGE WOOD

The Argentine "guayacan" or "ibirá-bera," *Caesalpinia melanocarpa* Gris., is a short-boled, heavy-limbed, widespreading tree, with a fairly symmetrical bole sometimes three feet in diameter and free of branches for 20 feet. The hard, thin bark is greenish or mottled gray and green, suggesting that of lignum-vitae (*Guaiacum officinale* L.). The leaves are doubly compound with very fine leaflets and are deciduous; the small, yellow, clustered flowers are followed by small leathery black pods very rich in tannin.

The "guayacan" is a common tree throughout the quebracho forests of the region known as the Gran Chaco, often averaging between 5 and

10 per acre with a total yield, however, of less than 2000 board feet. The timber enters the local markets in the form of hewn logs, railway ties, fence posts, and telegraph poles, but is rarely found in the cities. It is sometimes used by wheelwrights as a substitute for "lapacho" (*Tecoma*) for spokes and has many minor uses requiring a hard, strong, and durable material. The chief objection to it is the difficulty in working it with ordinary tools.

In the rain forests of northeastern Brazil is an unknown species of *Caesalpinia*,[93] known as "páo ferro" (iron wood), a name given to various other hard-wooded trees. It occurs in small groups or as scattered individuals, reaches a height of about 100 feet with a well-formed trunk usually two to three feet, rarely five feet, in diameter, and clear of limbs for about 50 feet. The leaves and bark and wood are very similar to those of the "guayacan" of Argentina. The wood is used locally for railway ties and heavy durable construction, but does not enter the larger markets.

A wood known in the New York market as brown ebony or coffee wood, and in European markets as partridge wood, is obtained from Venezuela and is the product of *Caesalpinia Granadillo* Pittier, a new species very closely related to *C. Ebano* Karst. of Colombia. It is known locally as "ebano" and "granadillo" and is used for heavy, durable construction. The timber is exported in log form, mostly 10 feet long and from 12 to 24 inches in diameter. The bark is thin, smooth, and brittle, with a mottled greenish outer layer and reddish beneath. The dark brown or coffee-colored heart is one of the principal woods used in the manufacture of umbrella handles. The tree is often planted in the West Indies for decorative purposes.

A wood almost identical with the latter and used for the same purpose is obtained in the State of Sinaloa, Mexico, and shipped in small quantities regularly to San Francisco and occasionally to New York. It is known locally as "ebano," on the San Francisco market as mesquite, and in New York as brown ebony or coffee wood. The same or very similar wood is found in Nicaragua where it is called "eleten"; it is not exported.

THE WOOD

Caesalpinia Granadillo Pittier (and closely related species)—*Partridge Wood.*

Common names: Partridge wood, coffee wood, brown ebony, mesquite (Trade); granadillo, ebano (Venez., Curaçao, Mex.); yaque, cuji yaque (Venez.); eleten (Nic.); páo ferro (Braz.).

General properties: Color chocolate-brown or coffee-brown with fine ves-

[93] This may be *C. ferrea* Mart., sometimes called "juca" and "ymirá-itá."

sel lines of lighter shade; deepening upon exposure; not highly lustrous. Sapwood yellowish or pinkish-white; sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) 1.10 to 1.30. Weight 68 to 81 lbs. per cu. ft. Grain fairly straight to interwoven. Texture medium. Wood not easy to cut, is rather harsh, finishes smoothly and takes a good polish, is very strong and durable.

Growth rings: Distinct to indistinct; due mainly to fine concentric lines of parenchyma.

Parenchyma: About pores in wing-like patches which are often confluent into wavy tangential lines in portions of the growth rings; also in few to many fine irregularly spaced concentric lines mostly independent of the pores; distinct on all sections and usually producing fairly conspicuous pattern on tangential surface.

Pores: Of medium size; distinct; fairly numerous, but not crowded; occurring singly or subdivided radially two to several times; no definite arrangement except as linked tangentially by parenchyma.

Vessel lines: Distinct due to parenchyma.

Vessel contents: Gum deposits common.

Rays: Not visible without lens on cross and tangential sections; visible, but fine and inconspicuous, on radial surface.

Ripple marks: Present; readily visible in sapwood, but not always distinct in heart; regular or fairly so; all elements storied; number per inch, about 100.

Gum ducts: None observed.

Remarks: The "guayacan" of Argentina is finer-textured and the parenchyma is much less distinct than the woods described.

Material: Yale No. 2760* (Curaçao); 4427, 4430, 6651* (Venez.); 1810*, 4678* (Braz.); 4744, 5234 (Nic.). Asterisk indicates botanical material.

PELTOPHORUM

Of the ten species of this genus, five are credited to Africa and other parts of the Old World, four to the West Indies, and one to southern Brazil and Argentina. Apparently only two species, both in the American tropics, are of any commercial importance.

The "moruro" or "sabicú moruro" of Cuba, *Peltophorum adnatum* Gris., has been known to the export trade for many years under the name of "sabicú." It often attains very large dimensions and has rather conspicuous yellow flowers, fern-like leaves that are glossy above and rusty beneath, and bark that is fine and smooth. The mahogany-like wood is of a dark red or purplish-brown color, hard and heavy, but of good cabinet qualities, and is used for furniture, interior trim, and vehicle construction. Since it is highly durable it is employed locally for various kinds of outside construction, fence posts, and railway ties.

THE WOOD

Peltophorum adnatum Gris. *Moruro.*

Common names: Sabicú, horseflesh mahogany (Trade); moruro, moruro rojo, moruro abey, moruro de sabana, abey hembra, palo de rayo, sabicú, sabicú moruro, zapatero (Cuba).

General properties: Color deep red or purplish-brown with white-dotted vessel lines; not highly lustrous. Sapwood nearly white.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) 1.02. Weight about 63 lbs. per cu. ft. Grain roey. Texture medium. Not difficult to work, finishes smoothly, takes a good polish, is very strong, but rather brittle, highly durable.

Growth rings: Usually poorly defined; sometimes distinct to variations in density.

Parenchyma: In poorly defined patches about the pores and in irregularly spaced, fine concentric lines; also diffuse; has a purplish color; scarcely visible without lens and not always distinct with it.

Pores: Rather few and large; readily visible; scattered irregularly; occurring singly or subdivided; many with white substance in them.

Vessel lines: Prominent; appearing as deep red scratches or as white-dotted penciling.

Vessel contents: White substance common, conspicuous. Red gum also present.

Rays: Very fine; invisible on cross and tangential sections; fine and indistinct on radial, being of same color as the background.

Ripple marks: Absent.

Gum ducts: None observed.

Material: Yale Nos. 4940 (collected by Mr. G. C. Bucher of Santiago, with leaves and flowers), 5013 (Cuba).

"CAÑA FISTOLA"

The "caña fistola" or "ibirá-puitá," *Peltophorum Vogelianum* Benth., is a very common tree in the forests of northwestern Argentina and of Paraguay. It makes its best growth on the deep red clay loam on the terraces of the Paraná River and its tributaries, where it occurs scattered in amongst the other hardwoods of that region. It reaches a height of 125 feet, with a rather short, irregular bole not infrequently six feet in diameter, with a swollen or buttressed base. The bark is dark brown and rough, and reminds one of the sycamore (*Platanus*). The leaves are large, doubly pinnate, with a great many rather small leaflets. The bright yellow flowers are borne in showy spikes which stand above the foliage and make the tree highly ornamental. The fruits are glossy red-brown winged pods, borne in great profusion.

The wood has a marked tendency to warp and twist in seasoning and

this interferes seriously with its usefulness, though it could doubtless be overcome by proper handling and kiln-drying. The wood in the natural state is not especially attractive, but when finished it is lustrous and handsomely figured with prominent wavy vessel lines and various shades of color. It is used in general construction, carpentry, turnery, and cabinetwork, and in the manufacture of vehicles and for railway ties. The bark and sawdust are said to be the source of a purple dye.

THE WOOD

Peltophorum Vogelianum Benth. *Caña Fistola.*

Common names: Caña fistola, cañafistula, ibirá-puitá, ybirá-pyitá, ybirá-pyitá-guazú, ivirá-pitá, yvira-pitá, virapitá (Arg.); caña fistola, angico ? (Braz.).

General properties: Pinkish to reddish, with lighter or darker streaks or stains; unfinished surface dull. Sapwood thick, pinkish-gray, not sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy to moderately so. Sp. gr. 0.75 to 1.04 (Castro). Weight 47 to 64 lbs. per cu. ft. Grain irregular. Texture medium. Wood twists and warps in seasoning, cuts readily, takes a high polish; deeply colored wood appears highly durable.

Growth rings: Usually distinct, adding figure to tangential surface, but not sharply defined; due mostly to differences in color.

Parenchyma: In roughly rounded patches about the pores and sometimes uniting them into wavy tangential series, visible, but often inconspicuous due to their color blending into background; sometimes in fine concentric lines limiting growth rings; also diffuse.

Pores: Large and distinct; fairly numerous; generally well distributed, with tendency to diagonal and tangential arrangement; mostly single, sometimes subdivided, usually open.

Vessel lines: Conspicuous; usually darker than background.

Vessel contents: Gum deposits and white substance common.

Rays: Very fine; invisible on cross section, faintly visible on tangential, low and inconspicuous on radial surface, appearing slightly darker than background.

Ripple marks: Usually absent; some specimens show tendency to their formation, but they are always very wavy and irregular, though readily visible.

Gum ducts: None observed.

Material: Yale Nos. 544, 1081, 1109, 1728, 1733, 5300, 6216 (Arg.); 3127 (São Paulo, Braz.).

MELANOXYLON

This genus consists of a single species, *Melanoxylon Brauna* Schott, a large Brazilian tree found in the coastal rain forests from Bahia to

São Paulo and, in places (*e.g.*, Minas Geraes), extending into the savanna forests. It is known locally as "braúna," "graúna," or "baraúna." The tree reaches a height of 90 to 110 feet, with a smooth, straight, well-formed bole, without buttresses, and upward of four feet in diameter. The leaves are imparipinnate with numerous opposite or nearly opposite, smooth, leathery, ovate-lanceolate leaflets sometimes three inches long and an inch wide. The flowers are large and yellow and in showy clusters. The pods are rather large, with depressions between the seeds, which have rectangular wings.

The blackish-brown wood is common in the markets of Rio de Janeiro and is much used for works in contact with the ground and for various kinds of heavy durable construction, such as beams, sills, and posts in houses, bridge timbers, and railway ties, for which it is rated first-class. It is also employed in vehicle manufacture, particularly for spokes, and for flooring and high grade furniture. The bark supplies tanning material, and both bark and wood are said to yield a beautiful reddish-brown dye.

As in the case of other important timbers, there are various substitutes. In the Yale collections, there are eight specimens labeled "braúna," "graúna," and "baraúna," of which one is *Melanoxylon*, three (Nos. 3227, 3551, 4696) are legumes of unknown species, two (Nos. 3116, 3209) are probably species of *Nectandra* (Lauraceae), and two are *Schinopsis brasiliensis* Engl. (Anacardiaceae).

THE WOOD

Melanoxylon Brauna Schott — *Braúna.*

Common names: Braúna, baraúna, graúna, graúna preta, graúna parda, garaúna, maría preta, perovaúna (Braz.).

General properties: Color dark brown to almost black; somewhat streaked; rather lustrous. Sapwood thin, yellowish, sharply defined.

Without distinctive odor. Taste somewhat astringent.

Hard and heavy. Sp. gr. (air-dry) about 1.00. Weight about 62 lbs. per cu. ft. Grain somewhat roey. Texture medium to somewhat coarse. Wood not very difficult to work, finishes smoothly, holds its place, is very strong and highly durable.

Growth rings: Absent or very poorly defined.

Parenchyma: In small amounts about pores and occasionally in fine tangential lines; not distinct.

Pores: Rather small; visible; numerous and often crowded; fairly well distributed; occurring singly or more often in radial groups of two to several pores each; mostly open.

Vessel lines: Numerous, not very distinct.

Vessel contents: Tyloses and gum deposits common.

Rays: Very fine; visible on cross section in sapwood, but not in heartwood; invisible on tangential; visible, but fine, low, uniform, and scarcely distinct on the radial surface.

Ripple marks: Of local occurrence, irregular and difficult to count; usually more distinct without lens than with it; all elements more or less storied; about 65 to 70 marks per inch.

Gum ducts: None observed.

Material: Yale No. 3268 collected with leaves by Dr. Whitford in Espirito Santo, Brazil.

SWARTZIA (TOUNATEA)

This genus consists of about 85 species of trees widely distributed throughout the tropics of the world. They seem to be mostly small or medium-sized trees with very hard, dark-colored woods, the so-called ironwoods, of little commercial importance. The leaves are imparipinnate, sometimes with winged and appendaged petioles, and often with large leaflets which are few in number and sometimes reduced to one. The flowers have a single large yellow petal, and the fruits, which often are egg-shaped or rounded, are leathery or fleshy.

There are various species in the Guianas, the best known being *Swartzia tomentosa* DC., called "wamara" or ironwood in British Guiana and "ferréol" in French Guiana. It is not abundant, grows in sandy soil, and is usually less than 75 feet high and 16 inches in diameter. The sapwood, which is very thick and nearly white, decays very rapidly, but the heart is highly durable. It is not extensively used because of its hardness, but is sometimes employed in turnery, inlaying, and cabinetwork, and for making walking sticks, cogs, and shafts. The Indians use it for bows and clubs. The sapwood apparently would make an excellent substitute for hickory (*Carya*) for various purposes requiring a very strong, tough, and resilient material.

THE WOOD

Swartzia tomentosa DC. *Wamara.*

Common names: Wamara, wamaru, womara, brown ebony, clubwood, ironwood, baracarra, wanebala (B. G.); ferréol, bois fer, panacoco rouge, gran panacoco, bois de pagaie blanc, bois de perdrix, perdrix, heistère rouge, anacoco (Fr. G.); apoetoe, boucara (Sur.); páo de remo, hucuya, anacoco wanebala (Braz.); legno ferro, legno carne di cavallo (Ital.); páo ferro (Port.); pferdefleischholz[94] (Germ.). OTHER SPECIES: Parakusan, lara-ku-sana, bastard yararu, serebadan, bania, ebony, ironwood, siribidanni (B. G.); montouchy, panacoco, bois dard, bois à flèches, bois de perdrix, bois pagaie, tounou, sikki-sikki-danni, siki-siki-danna, yakelele (Fr. G.); yzerhart, isrihati

[94] This name is more commonly applied to *Mimusops Balata.*

(Sur.); mïrá-pishuna, moçitahyba, muiracutáca, pacapeua, pacora de macaco, paracutáca, pitaïca (Braz.); cútaro, cornudo (Pan.); naranjillo, naranjito (Mex.).

General properties: Color deep purplish, becoming black upon exposure; with fine tracings of vessel lines on tangential surface; lustrous. Sapwood thick, whitish or yellowish, sharply, but rather irregularly defined.

Without characteristic odor and taste.

Extremely hard and heavy. Sp. gr. 1.05 to 1.28 (B. G.). Weight 65 to 80 lbs. per cu. ft. Grain straight. Texture fine and uniform. Wood difficult to work, finishes smoothly, takes a high polish, is very strong and highly durable.

Growth rings: Absent or not distinct; sometimes indicated by wider spacing of parenchyma.

Parenchyma: In numerous, usually closely spaced, regular to very irregular concentric lines connecting the pores; readily visible on all sections and producing a distinct pattern on the tangential surface; sometimes the lines are short or broken.

Pores: Small or medium-sized; fairly distinct; rather few and scattered; mostly solitary, sometimes subdivided; often closed in heartwood.

Vessel lines: Usually distinct, but not conspicuous except when white contents are present.

Vessel contents: Tyloses present; white substance sometimes present.

Rays: Invisible on cross and tangential sections; fine, uniform, low, and scarcely distinct on radial surface.

Ripple marks: Present; fairly regular; all elements storied; distinct in sapwood; fine lines between ray tiers distinct under lens; about 90 per inch.

Remarks: The available woods of this genus, representing probably eight or nine species, are much alike in their structure. The color varies from rich red to purplish or black. There are differences in the parenchyma, which in some cases is in regular and very closely spaced concentric lines or narrow bands, in others the concentric lines are rather widely spaced and between them are numerous broken and irregular lines. The ripple marks vary from 90 to 115 per inch.

Material: Yale No. 5112 from British Guiana Department of Lands and Mines (their No. 518A); 5395 (Fr. G.). Other species: Yale Nos. 5113, 5114 (B. G.); 5397, 5398 (Fr. G.); 4176 (Sur.); 4722 (Braz.); 2963, 2964 (Pan.).

ZOLLERNIA

This genus consists of seven or eight species of Brazilian trees and shrubs, but little information is available concerning them. The "páo santo," *Zollernia paraënsis* Huber, is a medium-sized tree with a long straight trunk growing in the lower Amazon region. The extremely dense wood is somewhat oily and is sometimes used in bearings as a substitute for lignum-vitae (*Guaiacum*). The timber is not plentiful, but

limited amounts are being exported for the manufacture of cutlery handles, billiard cue butts, and various articles of turnery.

THE WOOD

Zollernia paraënsis Huber — *Páo santo.*

Common names: Páo santo, muirapinima preta (Braz.); santo wood. Other species: Moçitahyba (Braz.).

General properties: Color variable from variegated olive-brown to greenish-black; often striped; has waxy appearance and feel. Sapwood yellow; sharply defined.

Odor mildly fragrant. Taste not distinctive.

Extremely hard and heavy. Sp. gr. (air-dry) 1.30 to 1.33. Weight 81 to 83 lbs. per cu. ft. Grain somewhat interwoven. Texture rather fine and uniform. Wood difficult to cut; splits with an irregular and rather harsh and splintery fracture; finishes smoothly; is very durable.

Growth rings: Often fairly distinct on account of wider spacing of parenchyma lines.

Parenchyma: In very fine wavy or broken concentric lines, faintly visible on cross section without lens; uniting pores; spacing about twice the distance between rays, with occasional wider gaps.

Pores: Small, but visible as white dots on dark background; not very numerous; well distributed; without definite arrangement except as linked tangentially by parenchyma; occurring singly or in pairs; many of them closed.

Vessel lines: Showing as fine white lines.

Vessel contents: White deposits abundant.

Rays: Invisible without lens on cross and radial sections; very fine, but visible on radial surface.

Ripple marks: Present; visible without lens; very regular to fairly so; all elements storied; number per inch, 90 to 95. Wood parenchyma cells (four per strand) in secondary seriation, visible under lens.

Gum ducts: None observed.

Remarks: The lighter-colored material resembles *Dipteryx.*

Material: Yale No. 5350A, collected by Mr. Algot Lange in lower Amazon region, Brazil; also two unnumbered specimens belonging to same collector.

HOLOCALYX

This genus consists of two species, *Holocalyx Balansae* Micheli of Argentina and Paraguay, and *H. Glaziovii* Taub. of São Paulo, Brazil. They are called "alecrim" in Brazil, "alecrin" or "ibirá-pepé" in Argentina, and "uripapa" in Paraguay. The two species are much alike and are common trees of the dry forests. They have rather short trunks rarely three feet in diameter and usually much smaller. The pinnate

leaves have many pairs of dark green, shiny, linear leaflets set closely together along the midrib. The flowers are small and the fruits are large, egg-shaped or rounded. The "alecrim" of Brazil is sometimes erroneously referred to *Pithecolobium.*

The hard, tough, and strong wood has many of the properties of hickory (*Carya*) and is considered excellent for hubs, spokes, and felloes of wheels. The small heartwood is highly durable and is used in heavy construction, carpentry, turnery, and for house posts. It makes excellent fuel and charcoal. The amount available is limited and the timber is not exported.

THE WOOD

Holocalyx Balansae Micheli — *Alecrin.*

Common names: Alecrin, ibirá-pépé, ybirá-pepé (Arg.); uripapa (Para.); alecrim (Braz.).

General properties: Color purplish-brown with darker streaks, sometimes almost black. Sapwood very thick, yellowish white, sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) about 1.00. Weight about 62 lbs. per cu. ft. Grain fairly straight to roey. Texture rather fine. Wood not very difficult to work, takes a high polish, is very tough, strong, and durable.

Growth rings: Fairly distinct, due to wider spacing of the parenchyma lines.

Parenchyma: In very numerous, wavy concentric bands, including the pores and suggesting elm (*Ulmus*); also in occasional finer and more uniform lines independent of the pores; producing fine pattern on tangential surface.

Pores: Small; indistinct; not very numerous; well distributed; mostly in radial groups of two to four; open.

Vessel lines: Fine and indistinct.

Vessel contents: Some gum deposits noted.

Rays: Invisible on cross and tangential sections; low, uniform, and scarcely distinct on the radial surface, appearing somewhat darker than the background.

Ripple marks: Present; all elements storied; regular or fairly so; indistinct without lens; 115 to 125 per inch. The parenchyma cells, two per strand, are in secondary seriation, visible under lens in heartwood.

Gum ducts: None observed.

Remarks: The wood of "alecrim" (Yale No. 3122) from São Paulo, supposed to be *H. Glaziovii* Taub., is practically identical with this species, though the heartwood is absent from the specimen. The structure is in many ways similar to that of the Argentine "rabo," *Lonchocarpus albiflorus* Hassl. (Yale No. 1693).

Material: Yale No. 1705 collected with botanical material by H. M. Curran in vicinity of Puerto Leon, Misiones, Arg.; 6252 (Arg.).

25c. PAPILIONATAE

SWEETIA

There are 12 known species of this genus, of which 11 are credited to Brazil, the remaining one to Central America. The "itaúba-rana" of the Amazon region, *Sweetia nitens* Benth., produces a hard, heavy, tough wood of rather fine texture and interwoven grain. The color is a lustrous brown with darker streaks, showing fine pencil-striping of lighter shade due to the parenchyma about the vessels; the yellowish sapwood is distinct, but the line of demarcation is not sharp. It is said to be used for general construction, house props, fence posts, and fuel.

The "perobinha" of São Paulo, *S. elegans* Benth., is a tree of medium height, with pinnately compound leaves having five to eight leaflets, and clusters of small white flowers blooming from September to November. The wood is said to be of a light yellow color with reddish patches. It is used in carpentry and joinery, for fuel, charcoal, and miscellaneous purposes. The leaves serve as forage for cattle.

A tree known locally in Bahia as "brazilette," but classed with "peroba" wood on the market, is probably of this genus. It occurs singly or in groups, especially on steep slopes near rivers, and grows to a height of 125 feet, with a bole four to five feet in diameter, free of branches for 50 feet. It has a thin tough bark, much the color of "vinhatico espinho" (*Pithecolobium* sp.), and on this account these trees are likely to be confused in timber estimating. The wood is used only locally. The color is a pale brown with lighter and darker striping; the sapwood is thin and white. The wood is hard, heavy, strong, tough, and durable and the logs are usually sound. It may prove to be one of the most desirable woods of the region for export to be used for handles, flooring, spokes, and many of the purposes now requiring oak, hickory, and ash. "Fabrication tests on 'peroba' indicate that it will turn with slightly more difficulty than hard maple. The turnings made were, on the whole, very good, being smooth, beads sharply cut, and small diameter cuts at sharp angles to the grain fairly smooth. Shearing cuts were excellent. Dowels produced were good, but showed a tendency to warp on long standing unless well bundled."[95]

Sweetia panamensis Benth. occurs from central Panama to Michoa-

[95] Babbitt, Will C.: Turnings from Brazilian hardwoods, *Wood Turning* (Milwaukee), 16:7:18, Apr., 1923.

The wood for these tests was supplied by Mr. H. M. Curran and is the same as Yale No. 4702. Tests on mechanical properties gave the following results: Weight (air-dry) 51.3 lbs. per cu. ft. Crushing strength parallel to grain, 7070 lbs. per sq. in. Bending: modulus of elasticity 1,658,400 lbs. per sq. in., fiber stress at elastic limit, 9110 lbs. per sq. in.

can and Guerrero, Mexico. In Panama it is called "malvecino" (bad neighbor), in Mexico "huesito" (little bone), and in Guatemala "chichipate." In Panama it appears to be usually a low-branched tree about 50 feet high and up to 16 inches in diameter, but in Guatemala it attains a height of 100 feet, with a trunk two feet or more in diameter and free of branches for 50 or 60 feet. The grayish bark is about a quarter inch thick and with lines of corky growths like warts. The leaves are compound, the leaflets, five to 13 in number, arranged alternately along the petiole which is three to six inches long. The flowers are small, white or yellowish, and arranged in terminal or axillary racemes.

THE WOOD

Sweetia panamensis Benth. ***Chichipate.***

Common names: Chichipate (Guat.-Hond.); huesito, huesillo (Mex.); malvecino (Pan.); Billy Webb (Br. Hond.). Other species: Itaúba-rana, peroba mirim, perobinha, peroba do Bahia, brazilette, carnaveira ? (Braz.).

General properties: Color brown with lighter and darker shades; lustrous. Sapwood yellowish or nearly white; sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) about 1.00. Weight about 62 lbs. per cu. ft. Grain finely roey. Texture rather fine. Wood tough and strong, easy to saw, but rather difficult to finish, takes a high polish, appears durable.

Growth rings: Not always distinct; sometimes indicated by differences in density and color, with or without fine line of parenchyma.

Parenchyma: In small amount about pores and sometimes connecting them irregularly; in some places more abundantly developed than in others; visible, but not conspicuous; sometimes in narrow lines, independent of pores and apparently limiting growth rings.

Pores: Small; barely visible except on account of parenchyma; numerous; well distributed; occurring singly or more often in pairs or small groups of three or four; open. Narrow zones deficient in pores sometimes occur.

Vessel lines: Fine and not conspicuous; appearing as lighter or darker than background, depending upon the lighting.

Vessel contents: Some gum and occasional white deposits noted.

Rays: Invisible or nearly so on cross and tangential sections; fine, uniform, and scarcely distinct on radial surface.

Ripple marks: Present; fairly regular; all elements storied; faintly visible without lens; number per inch, 120.

Gum ducts: None observed.

Remarks: The wood of the "brazilette" or "peroba do Bahia" (Yale No. 4702) is much like this, but has parenchyma about the pores and the ripple marks are coarser (about 60 per inch) and much more distinct. The leaflets of this tree are opposite. A specimen of "itaúba-rana" (No. 16, "L. Agassis" (Col.) resembles *Sweetia panamensis*, but the parenchyma is more abundantly developed. In another specimen (Yale No. 3741) of "chichipate," *Sweetia*

sp., the parenchyma is very sparingly developed, the density is less, and the grain is straighter.

According to C. Hummel (*Report on the forests of British Honduras,* 1921, p. 59), *S. panamensis* is fairly common in British Honduras, and the hard wood is good for trucks, carts, wheels, and tool handles.

Material: Yale Nos. 3673, 3732 collected by Messrs. Whitford and Stadtmiller with fertile herbarium material, Guat.-Hond.

MYROCARPUS

This genus consists of two known species, *Myocarpus frondosus* Fr. Allem. and *M. fastigiatus* Fr. Allem., occurring from Espirito Santo, Brazil, into Argentina and Paraguay. They are valuable timber trees and are known as "cabreúva" or "oleo pardo" in Brazil, and as "incienso" or "cabreúba" in Argentina. The two species are very much alike and the woods are practically identical; they are very commonly confused with *Myroxylon. M. frondosus* appears to be more common.

"Incienso" is fairly abundant in the forests of northeastern Argentina, Paraguay, and southern Brazil. It does not form pure stands and over considerable areas will not average more than one or two trees per acre. It reaches a height of 125 feet and diameters up to three or four feet, the commercial sizes ranging from 18 to 24 inches. It is slender, symmetrical, with a clear length of 50 to 60 feet in the forest, and a rather narrow, small-limbed crown. The resinous bark is heavy, rough, and deeply fissured, resembling that of the persimmon (*Diospyros virginiana* L.), or the black gum (*Nyssa sylvatica* Marsh.). The leaves are compound with several medium-sized alternate leaflets with transparent lines and dots; the flowers are small, white and in spikes; the fruits are peculiar winged pods with one or two seeds in the lower end.

The annual consumption of this timber in Argentina is between one and two million board feet. It reaches the Buenos Aires market in the form of squared logs and is a highly appreciated and much sought for timber. It is used in the manufacture of heavy ornamental doors and window frames and in general heavy interior construction. The dark brown wood has a strong, but pleasant, odor which is said to protect it against insect attack and makes it suitable for clothes chests and wardrobes.

According to Pereira,[96] "the timber of 'oleo pardo' is one of the most handsome in the world. The woodwork of old churches obtained from the 'oleo pardo' is renowned for its fine qualities." It is used for articles *de luxe,* cabinetwork, turnery, carriage building, interior work of first

[96] Pereira, Huascar: *The timber trees of São Paulo, Brazil,* p. 61.

quality, and shipbuilding. It is rated as a first-class timber for railway ties and lasts about 11 years.

The bark of these trees yields a resin with the odor of incense and resembling the balsam of Peru obtained from species of *Myroxylon*. This resin is used for medicinal purposes, and was formerly employed by the Jesuits as incense in the old missions in Argentina.

THE WOOD

Myrocarpus frondosus Fr. Allem. *Cabreúva; Oleo pardo.*

Common names: Cabreúva, cabriúva, cabreúva amarella, caboré, oleo de caborehyba, oleo pardo (Braz.); incienso, incienso cabrióba, cabriúba, ici (Arg.).

General properties: Color lustrous walnut-brown with tendency to dark streaks; sometimes with a yellowish tinge. Sapwood white; sharply defined.

Very pronounced pleasant spicy scent. Taste not distinctive.

Hard and heavy. Sp. gr. 0.87 to 0.97 (Castro). Weight 50 to 60 lbs. per cu. ft. Grain variable from straight to finely roey. Texture medium. Not very easy to work, rather harsh, takes a high polish, holds its place, is very strong and durable.

Growth rings: Usually fairly well defined by fine concentric lines of parenchyma and sometimes by differences in density and color; sometimes distinct on longitudinal surfaces.

Parenchyma: Fairly abundant; readily visible, but not conspicuous; in fine concentric lines, usually distant and apparently limiting growth rings, but sometimes rather closely spaced; often joining pores irregularly into wavy, broken tangential lines.

Pores: Small; open; distinct, but not conspicuous; usually in short radial groups as though subdivided two to several times; very numerous; well distributed; often joined by parenchyma into wavy lines more or less uniform, which may be distinct on tangential surface in irregular pattern.

Vessel lines: Fine and inconspicuous.

Vessel contents: Gum deposits localized as small specks in vessels, but not distinct without lens. No white deposits observed.

Rays: Invisible on cross and tangential sections; visible on radial, but fine and inconspicuous.

Ripple marks: Present; all elements storied; very uniform; faintly visible without lens; number per inch, 100 to 120.

Gum ducts: None observed.

Remarks: This wood has many features in common with the "oleo vermelho" (*Myroxylon*). The principal points of distinction are the color, which is brown instead of red, the more abundant parenchyma, and the finer rays and ripple marks.

Material: Yale Nos. 3287*, 2075, 3137, 3317, 4250 (Braz.); 912, 1089, 1095, 1126, 4126 (Arg.). Asterisk indicates botanical material.

MYROXYLON (TOLUIFERA)

Although about a dozen species of this genus have been named, only two or three of them are well known. They are balsamiferous trees widely distributed throughout tropical America. They resemble *Myrocarpus* so much that the trees of the two genera are often confused, but the wood of *Myroxylon* is red, while that of *Myrocarpus* is brown.

The most widely known species is *Myroxylon Pereirae* Klotzsch (= *Toluifera Pereirae* Klotzsch), which supplies the balsam of Peru introduced into Europe by the Spaniards in the sixteenth century. This tree is a native of the Balsam Coast, a tract of land on the Pacific coast of Central America which formerly belonged to Guatemala, but is now part of Salvador. The coast was so named because originally balsam was its only article of export, and inasmuch as this product was usually sent by the Guatemalan merchants to Callao, Peru, for transshipment to Spain, it came to be known as balsam of Peru. At the present time balsam is shipped directly from points along the Balsam Coast, which extends from Acajutla to La Libertad. The trees yielding it are very numerous and apparently limited to one species, for in no other part of the coast, seemingly identical in soil and climate, are naturally grown trees met with. The balsam tree has been introduced into the tropics of the Old World and is said to thrive very well in Kamerun in West Africa, where small experimental plantations have been started. It has been successfully cultivated in Ceylon since 1861, and a considerable quantity of balsam is also being collected from trees which were planted near Calcutta, India. The Central American balsam trade is now receiving some competition from these points.

The methods employed by the Indians of the Balsam Coast in collecting the resin are very crude. Incisions of from nine to ten inches long and about two inches wide are made in the bark of the trunk during the dry season, and the areas from which the bark has been removed are wrapped with cloths. When the original flow ceases, the bark is heated by means of torches to stimulate further exudation. The cloths are allowed to remain on the naked wood for a few days, and are then removed and boiled in water to liquefy the resin; some of this sinks to the bottom and is collected after the water is poured off, the remainder being extracted by pressure. The balsam is boiled a second time, the foreign material removed, and the liquid poured into tins containing about 50 pounds each, for export. The best trees produce about four or five pounds a year for many years. The total quantity produced annually is said to be about 130,000 pounds, of which a little less than one-half comes to the United States. Before the war Germany was the

largest user. The balsam is a viscous, grayish-red substance with a vanilla-like odor and a bitter, burning taste. It must be kept in tightly sealed receptacles to exclude air and light to prevent deterioration. It was used by the aborigines in the treatment of wounds and cutaneous diseases and is now employed in the preparation of ointments, pomades, perfumes, and various proprietary remedies.

The fully developed balsam trees are about 100 feet high and three feet in diameter, but those now commonly met with are about 45 feet in height, and from 12 to 18 inches in diameter at the base. The wood is of a close grain, handsomely veined, nearly of a mahogany color, but redder. It has a very agreeable odor, which it retains for a long time, and takes an excellent polish. Balsam wood is highly esteemed for cabinetwork, but is rarely to be obtained, since the trees are seldom felled for the wood they yield.

Myroxylon toluiferum H. B. K. (= *Toluifera balsamum* L.) is a medium- to large-sized tree widely distributed in South America. The bark is the source of an oleoresin known to the trade as tolu balsam or "balsamum tolutanum," most of which comes from Colombia and Venezuela. The trees are tapped by cutting V-shaped gashes in the bark and collecting the resin in calabashes, or by hacking the bark irregularly and gathering the resin in palm leaves on the ground. The industry is of less importance than formerly. The balsam is used principally in the perfume industry and sometimes as an adulterant of the more valuable balsam of Peru.

The tree[97] occurs throughout the Andes into Argentina, and also in Paraguay, southern Brazil, and along the coastal regions as far north as central Bahia. It is found along the rivers and in coves of the dry interior, but is more common in the rain forests of the coast. The woods vary in color from dark red or purplish-red to reddish-brown, but are much alike in their structure and properties. In Argentina the wood is known as "quina" or "quina-quina" and is very highly esteemed for furniture and durable construction. In São Paulo it is commonly called "cabreúva" or "cabreúva vermelha," while farther north in Brazil the usual name is "balsamo," the same as that given to it in Venezuela and Colombia. It is exported from Brazil under the name of "oleo vermelho," and some of the cabinetmakers in New York consider it an excellent substitute for Cuban mahogany. There is a considerable supply of accessible timber in eastern and southern Brazil and it promises to become of much greater importance in the foreign trade as well as in the local markets where it has long been well and favorably known.

[97] There are probably three or four closely related species involved here, but the matter cannot be determined at present.

THE WOOD

Myroxylon toluiferum H. B. K. *Oleo vermelho.*

Common names: Oleo vermelho (Trade); balsamo, oleo vermelho, cabreúva, cabreúva vermelha, caboré, incienso (Braz.); quina, quina-quina, kina, kina-kina, kina morado, incienso (Arg.); quina-quina (Boliv.); balsamo, balsamo de tolú, tolú, tache (Col.); balsamo (Venez., Pan.); balsamo, palo de balsamo (Salv.); balsamito (C. R.).

General properties: Color reddish-brown, sometimes with a yellowish tinge when fresh; becomes deep red or somewhat purplish upon exposure; resembling Cuban mahogany; fairly uniform; sometimes with lighter and darker shades. Sapwood white; sharply defined.

Very pronounced pleasant spicy scent. Taste not distinctive.

Hard and heavy to moderately so. Sp. gr. (air-dry) 1.00. Weight about 62 lbs. per cu. ft. Grain variable from straight to finely roey. Texture medium; rather harsh. Not very difficult to work. Takes good polish.

Growth rings: Not always distinct. When present due to narrow poreless zones or to fine inconspicuous lines of terminal parenchyma. Sometimes there are color differences which give a banded appearance distinct on all sections.

Parenchyma: Inconspicuous; about pores and in fine distant tangential lines, mostly short and irregular.

Pores: Small; open; visible, but not conspicuous; mostly in short radial groups as though subdivided two to several times; very numerous; well distributed except for occasional narrow poreless zones.

Vessel lines: Fine to very fine; inconspicuous. Long and straight or alternating long and short in roey specimens.

Vessel contents: Localized deposits of red gum common, appearing as numerous dark specks in vessels. White deposits occasionally found and showing as distinct lines.

Rays: Very fine and numerous; barely visible without lens on cross section; invisible on tangential; visible on radial, but fine and inconspicuous.

Ripple marks: Present; very uniform; all elements storied; visible, but not very distinct without lens; number per inch, 90 to 100.

Gum ducts: None observed.

Remarks: See *Myrocarpus.*

Material: Yale Nos. 699, 709, 1467, 2072, 2518, 3109, 3136, 3195, 3278*, 3296*, 3390, 3441, 3521, 3589, 4685*, 4880 (Braz.); 528, 945, 1088, 1108, 4382, 4399 (Arg.); 334, 345, 465, 6658 (Venez.); 412* (Col.); 4343 (Pan.). Asterisk indicates botanical material.

MYROSPERMUM

This genus consists of one or two species of tropical American trees regarding which very little information is available. They are closely related to *Myrocarpus* and *Myroxylon*, and the three genera are frequently confused. The leaves resemble those of *Robina* and the leaflets have numerous translucent lines.

The "cereipo" of Venezuela, *Myrospermum frutescens* Jacq., is said to be a tree 50 to 60 feet high and usually less than a foot in diameter. The heartwood is of a dark-brown color more or less striped with black; the sapwood yellowish and sharply defined. It has no distinctive odor or taste, is very hard, heavy, and compact, difficult to cut across, but fairly easy to cut along the grain, takes a high polish, but being finely roe-grained is not easy to work; appears highly durable. Growth rings are indicated by narrow zones comparatively free of pores. Parenchyma is very sparingly developed about the pores, which show rather distinctly as numerous, small, light-colored dots against a dark background. The rays are extremely fine, faintly visible on cross section, invisible on tangential, scarcely distinct on the radial surface. Ripple marks are present, all elements storied, fairly regular, faintly visible without lens; number per inch, about 100. Wood resembles *Myroxylon* in structure, but has no odor and is brown instead of red. *Material:* Yale Nos. 344, 442*, 2657, 6653, 6654 (Venez.).

TORRESEA (AMBURANA)

This genus consists of a single known species, *Torresea cearensis* Fr. Allem. (= *Amburana Claudii* Schw. & Taub.), occurring in the dry regions of South America from Ceará, Brazil, to northern Argentina. It is a tree of medium to large size with unequally pinnate leaves having 11 to 15 alternate leaflets, yellowish-white caulescent flowers, and dark-colored, wrinkled, winged seeds. The seeds have a pronounced odor of "cumarin" (tonca bean) and are used for flavoring tobacco. The wood, which is likewise scented, is highly esteemed for furniture in Argentina, but the available supply of the material is very limited. In Minas Geraes, Brazil, "the excellent, highly prized wood is used in the manufacture of boards, rafters, window frames, fermentation vats, etc."[98] The tree is sometimes confused with *Pterodon* in Argentina.

THE WOOD

Torresea cearensis Fr. Allem. *Umburana.*

Common names: Umburana, umburana cheira, imburana, amburana, cerejeira, cumarú do Ceará, cumarú, trebol (Braz.); roble, roble del país, palo trebol (Arg.).

General properties: Color yellow, sometimes with a reddish tinge; not always uniform; rather oily looking; parenchyma produces distinct markings. Sapwood gray or oatmeal-colored; not very sharply defined.

Mild, but distinct odor and taste, suggesting cumarin or vanilla.

Of medium weight and density. Sp. gr. (air-dry) 0.60. Weight about 37

[98] *Pflanzenfamilien*, 3:3:387.

lbs. per cu. ft. Grain roey. Texture rather coarse. Wood cuts very easily and smoothly, saws rather woolly when fresh, has a waxy feel, is probably durable.

Growth rings: Poorly defined; when present, due to differences in color or shade.

Parenchyma: Very abundant about pores and pore groups, forming conspicuous diamond-shaped patches, irregularly confluent; very distinct on tangential surface, appearing duller and darker than the background.

Pores: Of medium size; distinct; not very numerous; well distributed; occurring singly or in radial groups of two to several.

Vessel lines: Conspicuous on account of parenchyma; rather wavy and irregular.

Vessel contents: Some dark or reddish gum and some white deposits noted; often distinct on longitudinal surfaces.

Rays: Very fine; faintly visible on cross and tangential sections; fine, but distinct, on radial surface, being of a darker color than background.

Ripple marks: Present, but not always distinct, being rather irregular, due to variation in height of the rays. Wood parenchyma may show secondary seriation visible only under lens.

Gum ducts: None observed.

Material: Yale Nos. 3281 (Espirito Santo), 3402, 3440 (Bahia), 4024 (Matto Grosso, Brazil); 910, 1110, 1111, 4397 (Arg.).

BOWDICHIA

This genus consists of two species, *Bowdichia nitida* Spruce of the Amazon region, and *B. virgilioides* H. B. K. of wider distribution in Brazil and northern South America. They are tall forest trees having imparipinnate leaves with numerous small leaflets; bluish-purple or white flowers in dense terminal racemes; slender, indehiscent pods provided with a narrow wing at the upper portion.

The trees yield hard, heavy, strong, dark-colored, and highly durable woods known by the common generic name of "sucupira," "sapupira," or "sebipira." Many different kinds are recognized, but from the information and specimens available it is not possible to determine their botanical status. Apparently, however, the name "sucupira" is now applied to woods of at least three genera, but their identities have yet to be determined. It is known that the woods of *Diplotropis* are sometimes called "sucupira."

"SUCUPIRA AMARELLA"

The identity of this wood is unknown, although it is sometimes referred to *B. nitida* and sometimes to *Ferreirea spectabilis* Fr. Allem. There are specimens in the Yale collections from northern Argentina and from Minas Geraes and Espirito Santo, Brazil. The leaves from a tree along

the Rio Doce in Espirito Santo are compound with nine to 15 alternate or sub-opposite, elliptical leaflets, the largest of which are about 1.5 inches long and 0.75 inch wide and slightly notched at the tip; the smallest leaflets are nearly round and about half an inch in diameter. The tree is said to reach a height of 125 to 150 feet with a long, well-formed bole sometimes more than three feet in diameter, covered with a dark brown or nearly black, ridged bark. The wood (Yale No. 3272) shows a very striking similarity to that of the tonca bean (*Dipteryx*).

THE WOOD

(Unknown) ***Sucupira amarella.***

Common names: Sucupira, sucupira amarella, maracahyba (Braz.).

General properties: Brownish-yellow when fresh, becoming darker upon exposure; rather streaked; looks waxy. Sapwood pale yellow; thin.

Odor somewhat rancid or vaguely like tonca bean. Taste bitter.

Very hard and heavy. Sp. gr. (air-dry) 0.93. Weight about 58 lbs. per cu. ft. Grain roey and interwoven. Texture medium. Wood harsh and splintery, difficult to work, takes a high polish, appears very durable; feels as if it were waxed.

Growth rings: Present or absent; when present are poorly defined and due to narrow poreless zones and fine broken line of parenchyma.

Parenchyma: In conspicuous patches about the pores and often connecting them irregularly; sometimes also in fine lines mostly independent of the pores.

Pores: Of medium size, but very distinct on account of parenchyma; numerous or fairly so; well distributed; occurring singly or in radially compressed groups of few to several pores each; mostly open.

Vessel lines: Distinct in proper light, due to parenchyma; appearing lighter than background.

Vessel contents: Gum deposits common.

Rays: Invisible or nearly so on cross section, invisible on tangential; visible on radial surface, appearing lighter than background and very regular.

Ripple marks: Present; all elements storied; regular; faintly visible without lens; number per inch, 110 to 115; wood parenchyma cells in secondary seriation.

Gum ducts: None observed.

Remarks: The pores are larger, the parenchyma more abundant, and the ripple marks finer than in *Dipteryx*. Otherwise these two woods agree very closely.

Material: Yale Nos. 1489, 3175, 3223, 3272* (Braz.); 548, 1106 (Arg.).

THE BROWN "SUCUPIRAS"

The woods commonly known as "sucupira" are of a deep chocolate-brown color, and bear a close resemblance to the "acapú" (*Vouaca-*

poua). There are various kinds which are much alike, but which are readily separable into two groups on the basis of the presence or absence of ripple marks. What is believed to be the genuine "sucupira" does not have ripple marks.

Mr. Curran says: " 'Sucupira' is the wood preferred to all others in Brazil for making hubs and felloes for cart wheels. The tree occurs in the coast forests, but is not abundant, and the logs entering the market are mostly from 12 to 18 inches in diameter. This is not a criterion, however, of the maximum size of the tree, since the native loggers usually bring out only the small and medium-sized logs of heavy timber. Another kind of 'sucupira,' known as 'sucupira-assú,' has been introduced into the market. It appears to be more abundant, but the wood is considered inferior."

THE WOOD

Bowdichia sp. *Sucupira.*

Common names: Sucupira, sapupira or sebipira (various other spellings), sucupira-assú, sucupira doce, sucupira mirim, sucupira d'agua, sucupira preta, sucupira roxa, sipipin (Braz.); alcornoque (Venez.).

General properties: Color brown or chocolate-brown with conspicuous pencil-striping of lighter brown; fairly lustrous. Sapwood nearly white; sharply defined.

Odor and taste absent or not distinctive.

Very dense, hard and heavy. Sp. gr. (air-dry) about 1.00. Weight about 62 lbs. per cu. ft. Grain wavy or roey. Texture coarse, harsh. Wood difficult to work, is very tough, strong, and highly durable.

Growth rings: Absent.

Parenchyma: Conspicuously about pores and pore groups, often joining them into wavy diagonal lines; conspicuous on all sections.

Pores: Rather large; very distinct on account of parenchyma about them; well distributed; occurring singly or in radial groups of few to several, in which the inner pores are much flattened radially; mostly open.

Vessel lines: Very conspicuous on account of parenchyma, which is much lighter colored than background; numerous and irregular.

Vessel contents: Some gum and white deposits noted.

Rays: Fine, but visible (though not always distinct) without lens, on cross and tangential sections; distinct on radial, being of lighter color than background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: In the other "sucupiras" of this group growth rings are usually distinct on account of poreless zones and arrangement of parenchyma; parenchyma is in prominent wavy and irregular tangential bands widening out to include the pores; ripple marks are present, usually visible without lens,

fairly regular, and about 90 to 95 per inch. (*Material:* Yale Nos. 3198, 4377, 3496, 3534, 4262.)

Two specimens labeled "sucupira" (Yale Nos. 2509, 3248) have the general structure of the preceding, but ripple marks are absent and the color is light brown with a reddish tinge.

The chief difference between what is believed to be the true "sucupira" and the "acapú" (*Vouacapoua*) is that in the former the pores are larger, the vessel lines coarser and more conspicuous, and the rays are not so fine.

Material: Yale Nos. 584, 2113, 3384, 3386, 3917, 3925, 4045, 4295 (Braz.).

DIPLOTROPIS

There are seven or eight species of this genus in Brazil and the Guianas, but the small amount of available information indicates that their woods are poorly known. This may be attributed to scarcity of the timber or to the confusion of the woods with others which closely resemble it. A specimen (Yale No. 4179) of "zwarte kabbes" of Surinam, bearing the scientific name of *Diplotropis guianensis*, bears a very close resemblance to a specimen (Yale No. 4720) labeled "sucupira assú" from Ilheos, Brazil. Moreover, Huber[99] states that *Diplotropis* sp. is known as "sapupira da varzea" in the Amazon region. Hence it is not unlikely that some of the "sucupira" of commerce is supplied by this genus. The wood also shows a striking similarity to the British Guiana "tatabu" or "tataboo," a leguminous wood of uncertain identity.

The "aramatta," *D. brachypetalum* Tul., of British Guiana is said to be a fairly common tree growing on sandy soil throughout the colony. It averages 80 feet in height, with clear lengths of 30 feet and diameters of 16 to 18 inches. The leaves are imparipinnate, with large leathery leaflets; the white or roseate flowers are in simple racemes; the flattened pods are oval or elongated, thick and leathery or almost woody, and contain one or two seeds. The Indians are said to use a decoction of the bark to destroy vermin. The wood is used to a limited extent for cabinetwork, furniture, houseframing and shipbuilding. In Surinam the wood is considered of good quality, though it is employed to only a minor extent in housebuilding. In French Guiana it is considered good for vehicle making, general construction, and piling. The name "coeur dehors" is applied there to this wood as well as to that of *Bowdichia*.

THE WOOD

Diplotrophis sp. *Zwarte Kabbes.*

Common names: Zwarte kabbes, levarte kabbes (Sur.); aramatta, aramatto,

[99] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 183 (1909).

araumatta (B. G.); coeur dehors (Fr. G.); sapupira da varzea (Amaz., Braz.).

General properties: Color brown, with an intermingling of lighter and darker shades and showing fine striping of vessel lines; appears somewhat waxy; polished surface has a satiny luster in proper light. Sapwood is brownish-white; sharply defined.

Odor and taste absent or not distinctive (in dry wood at least).

Hard and heavy. Sp. gr. (air-dry) 1.15. Weight about 71 lbs. per cu. ft. Grain irregular, but not roey. Texture medium. Wood hard to cut and rather difficult to finish smoothly on account of the irregular grain; very strong, tough, and durable.

Growth rings: Absent or very poorly defined.

Parenchyma: In distinct patches about the pores and sometimes uniting them into diagonal rows; rarely in short tangential lines.

Pores: Of medium size; conspicuous as rather large white dots on a dark background, due to parenchyma; numerous, but not crowded; occurring singly or subdivided; well distributed, though occasionally leaving irregular tangential zones which may give the appearance of growth rings; open.

Vessel lines: Conspicuous (on account of parenchyma) in proper light, appearing as narrow, light-colored stripes on a dark background.

Vessel contents: Gum deposits common.

Rays: Very fine; faintly visible on cross section and sometimes on the tangential; low, but distinct, on the radial surface, appearing lighter than the background.

Ripple marks: Absent or sometimes of local occurrence and very irregular.

Gum ducts: None observed.

Remarks: For detailed description of the minute anatomy see Janssonius, H. H.: Mikrographie einiger technisch wichtigen Holzarten aus Surinam, *Verh. d. Kon. Akad. v. Wetenschappen te Amsterdam* (2d sec.), 18: 2: 26-30, Feb., 1914.

Material: Yale Nos. 4179 (Sur.); 4720 (Braz.).

VOUACAPOUA

This genus, considered independently of *Andira*, with which it is sometimes classified, consists of a single species, *Vouacapoua americana* Aubl., the "acapú" of Brazil. It occurs scatteringly in British Guiana, is fairly common in parts of Surinam and French Guiana, and reaches its best development in the eastern Amazon region, especially in the state of Pará. According to Huber (*loc. cit.*, pp. 177-179), "acapú" is absent or very rare in the State of Amazonas, and the timber has been largely removed from the country tributary to the Bragança Railroad, where it was formerly abundant. Most of the present supply comes from the drainage of the Capim, Acará, and Mojú. The eastern limit of the species is apparently the Maracaña River.

The "acapú" is a tall, slender, smooth-barked tree, yielding a hard, heavy, strong, and very durable timber highly prized for certain kinds of construction and particularly for flooring in conjunction with some light-colored wood such as "páo amarello," *Euxylophora* (Rutaceae). It makes an extremely durable post timber and, where abundant, is the principal material used for this purpose. Limited quantities of the timber are now coming into the markets of the United States. It makes beautiful interior trim, but should be thoroughly kiln-dried before manufacture to prevent shrinkage and warping.

THE WOOD

Vouacapoua americana Aubl. *Acapú.*

Common names: Acapú, vacapou, vouacapú, wacapou (Braz.); wacapou, épi de blé (Fr. G.); bruinhart, berkhout, braunherz, wakabu (Sur.); blackheart, dakamaballi ?, partridge wood ? (B. G.); vouacapouholz, wegabaholz (Germ.).

General properties: Color chocolate-brown with prominent pencil-striping (vessel lines) of lighter brown. Sapwood light-colored; sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy; rather horn-like. Sp. gr. (air-dry) 0.87 to 0.92. Weight 54 to 57 lbs. per cu. ft. Grain fairly straight to somewhat roey. Texture moderately coarse; rather harsh. Not very easy to work, splits easily, takes good polish, finishes smoothly; is very strong and durable.

Growth rings: Present or absent; sometimes distinct, due to narrow, poorly defined zones, deficient in pores and sometimes with fine broken lines of limiting parenchyma.

Parenchyma: In conspicuous patches about pores and often connecting them into irregular patterns; sometimes in short fine lines at apparent limits of growth rings.

Pores: Of medium size, but appearing large and conspicuous on account of halo of wood parenchyma; numerous, well distributed; no definite arrangement, except when connected by parenchyma into irregular diagonal rows or festoons.

Vessel lines: Conspicuous because of parenchyma, producing light-colored stripes on dark background.

Vessel contents: Vessels mostly open; some gum and occasional white deposits noted.

Rays: Very fine; not distinct on cross and tangential sections without lens. Distinct on radial, being lighter-colored than background.

Ripple marks: Absent.

Gum ducts: None observed.

Material: Yale Nos. 2083, 3618, 3909, 4026, 5282 (Braz.); 4171, 4191 (Sur.); 5401 (Fr. G.).

EYSENHARDTIA

This genus, consisting of eight or nine species of shrubs and small trees, is distributed from western Texas and southern New Mexico and Arizona to southern Mexico, Lower California, and Guatemala. The wood of *Eysenhardtia polystachia* (Ortega) Sargent is of special interest because during the sixteenth, seventeenth, and early part of the eighteenth centuries it was celebrated throughout Europe for its reputed diuretic properties and for the remarkable fluorescence of its infusion in pure water. In the latter respect it is rivaled only by the Philippine "narra," *Pterocarpus indicus* Willd., and for a long time this and the Mexican wood were supposed to be the same and were called lignum nephriticum. Precious cups were turned from lignum nephriticum, and water drunk from them or from bowls in which a few chips had been allowed to remain was supposed to work marvelous cures. This is not surprising in view of the beautiful opalescence imparted to the water, varying in sunlight and shadow from orange and yellow to peacock-blue. The sources of lignum nephriticum remained uncertain for centuries and, in fact, were not positively established until 1915.[100]

Standley[101] says the Mexican plant is a shrub or tree 10 to 25 feet, with a hard, dense, reddish-brown wood, having a specific gravity of about 0.87. "The foliage of the tree is aromatic and the flowers are fragrant. In Mexico drinking troughs made from the wood are used for watering fowls, or a piece of the wood is put in their drinking water to ward off diseases. Palmer reports that in Sonora a decoction of the wood is given as a refreshing drink to fever patients. The wood is much used in some localities for kidney and bladder affections. It also gives a yellowish-brown dye." The common names are: Rosilla, palo cuate (Sinaloa); palo dulce (Mexico, Hidalgo, Puebla, Sonora, Jalisco, Oaxaca); coatl, coate, cuate (from the Nahuatl *coatli*, snakewater); palo dulce blanco (Mexico); taray (Nuevo León, Durango); vara dulce, varaduz (Durango, *Patoni*); leña nefritica, urza (Otomí); tlapalezpatli or tlapahoaxpatli.

DIPHYSA

This genus consists of about 10 species of shrubs and small trees found in Mexico, Central America, and northern South America. They are of some importance for the yellow dye which is obtained from the heartwood.

100 See Safford, W. E.: *Lignum nephriticum*—its history and an account of the remarkable fluorescence of its infusion, *Smithsonian Report for 1915*, pp. 271-298.

101 Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.*, 23: 2:444 (1922).

The best known species is *Diphysa carthaginensis* Jacq., sometimes called the bladder-pod tree, in allusion to the fruits. It is rarely more than 20 feet in height, and has a very irregular crown and a short, crooked and twisted trunk rarely eight inches through. Its range extends from the Guianas through Venezuela, Colombia, and Central America to southern Mexico.

The wood is of greenish or yellowish-green color, becoming dark brown or reddish-brown upon exposure; the sapwood is thin and yellowish-white. It is hard, heavy, strong, and extremely durable. Parenchyma is about the pores and in very numerous irregular, wavy lines and bands; the pores are readily visible, numerous, irregularly distributed, and mostly closed with tyloses. The rays are very fine and are not storied.

The wood is highly esteemed locally for house posts and in the manufacture of small agricultural implements. Formerly it was exported in a small way for the yellow dye which it yields. It is still used for this purpose locally as a substitute for fustic (*Chlorophora*). Green sticks set in the ground take root and grow and are accordingly used for live fence posts.

Common names: Bladder-pod tree (Eng.); diphysa, diphyse (Fr.); blasenschote (Germ.); vivaseca (Col.); cacique, macano (Pan.); palo amarillo (Guat.); guachipilín, guachipelí, huachipilín (Salv., C. R.); cuachepil (Mex.).

Material: Yale No. 2989 collected by Dr. Pittier in Panama; his No. 4641.

BRYA

This genus consists of a few tropical American species of shrubs or small trees, only one of which is well known. This is *Brya Ebenus* DC. of Cuba and Jamaica, which furnishes a limited quantity of small logs of highly prized wood known to the trade as cocus wood or green, brown, or West Indian ebony. The tree occurs in dry situations and is usually small, often shrubby, though individuals are said to become 50 feet high and 18 inches in diameter.

The following information is supplied by Mr. G. C. Bucher of Santiago, Cuba: "*Brya Ebenus* is known locally as 'granadillo' and on the market as cocus wood. Its range is along the dry ridges of this coast, on the savannas of the Rio Cauto Valley, and perhaps in other parts of the island. The tree, if it may be so called, is not over 20 feet high and branched into many fine straight twigs armed with thorns. The leaves and blossoms have practically no stalks, growing directly from the twigs. One peculiarity of this tree is the ease with which it drops its small leathery leaves in dry weather, renewing them when the rains

begin. The only lots of the wood that I have seen have been composed of very small sticks, and I believe that the minimum size accepted must show a 2½-inch heart at the small end. In the country that I know it would be difficult to find a lot worth while, as nearly all the best has been cut out long ago."

The wood has been known on the world's markets for a long time, appearing in the form of small logs with the bark and sapwood on, since the heartwood, the only part used, is said to season more uniformly in this condition. The Cuban material is considered the best and there is a good demand for it in the United States, where about 500 tons are consumed annually. About 300 tons are exported annually from Jamaica to England and there is still a considerable supply remaining, though it is not of the best quality. Wood of this or a closely related species is also obtainable in Mexico, Central America, and Colombia.

The principal use for cocus wood is in making musical instruments, particularly flutes, clarinets, etc., for which it is well adapted on account of its fine and uniform grain, its richness of coloring, and its resonance. Other uses are parquetry, inlay, brush backs, knife handles, walking sticks, umbrella handles, and numerous fancy articles. The presence in the wood of a resin, somewhat like that of lignum-vitae (*Guaiacum*), makes the material easy to turn and to polish and reduces the tendency to warp or check.

THE WOOD

Brya Ebenus DC. *Cocus Wood.*

Common names: Cocus or cocos wood, granadillo, green, brown, American, West Indian, or Jamaica ebony, torchwood (Eng.); amerikanische ebenholz (Germ.); legno granadillo (Ital.); granadillo (Span.); granadillo, ojo de perdiz (Cuba).

General properties: Color light yellowish-brown with dark streaks when fresh, becoming dark green, violet-brown or almost black upon exposure; usually beautifully veined. Sapwood yellowish or nearly white; sharply defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. (air-dry) about 1.20. Weight about 75 lbs. per cu. ft. Grain fairly straight to finely roey. Texture very fine and uniform. Wood somewhat oily, turns readily, takes a beautiful polish, is very strong, but heartwood is brittle; highly durable.

Growth rings: Fairly distinct, due mainly to relative abundance of parenchyma.

Parenchyma: In very numerous, fine, concentric lines, sometimes crowded, especially near the center of a stick, sometimes rather unevenly spaced in the inner portions of growth rings; faintly visible without lens in sapwood, and but often scarcely visible with lens in heartwood.

Pores: Very small; not very numerous; irregularly scattered; occurring singly or more often in radial groups of two to four; open in sapwood, closed in heartwood.

Vessel lines: Very fine and inconspicuous.

Vessel contents: Dark-colored gum abundant in heartwood.

Rays: Minute; not visible without lens on cross and tangential sections, scarcely distinct on radial surface.

Ripple marks: Present; fairly regular, all elements storied; not visible without lens; number per inch, 180 to 190.

Gum ducts: None observed.

Material: Yale Nos. 773, 824, 4081, 4998, 5356 (Cuba), the last collected with botanical material by Mr. G. C. Bucher, Santiago; 6402 (Jamaica).

DALBERGIA

This highly important genus consists of over 200 species of trees and shrubs widely distributed throughout the tropical regions of the world. Here belong two of the most valuable and important of East Indian forest trees, the "sissoo," *Dalbergia Sissoo* Roxb., and the blackwood or rosewood of southern India, *D. latifolia* Roxb. The African blackwood or Senegal ebony, *D. Melanoxylon* G. & P., is well known in the manufacture of musical instruments and in carving. In tropical America this genus produces the Brazilian rosewood, cocobolo, and Honduras rosewood; probably, also, the true kingwood of Brazil.

The woods of the genus exhibit a great range of variation in density from light and soft to extremely hard and heavy, and in color from white or gray to handsomely variegated or black. In general, the structural features are fairly distinctive. The pores are rather large, few, and irregularly scattered; wood parenchyma shows a more or less well-defined concentric arrangement; the rays are very fine; ripple marks are present.

BRAZILIAN ROSEWOOD

This wood, one of the best known from the Brazilian forests, has been an important article of export from northeastern coastal forests for upward of 300 years. It occurs in the rain forests in association with the brazilwood (*Caesalpinia echinata* Lam.), and the exploitation of the two timbers has been concurrent.

In an attempt to profit by the reputation of the true rosewood, known locally as "jacarandá," the producers extended the name to cover any wood that bore resemblance to the genuine, thus bringing about a state of confusion much the same as in the case of mahogany. This was made easier by the fact that the true rosewood exhibits considerable variation

in color, ranging from brown to purplish-black and often highly variegated. These variations in "jacarandá" are distinguished by common specific names such as "tan," "rosa," "preta," "roxa," "violeta," etc., and certain writers attempt to refer all of these kinds to distinct botanical species. To make matters worse, some botanists have made the mistake of confusing the local name "jacarandá" with the genus *Jacaranda* of the family Bignoniaceae. Thus one can find authority for referring the Brazilian rosewood to many species, several genera, and even to two different families.

There is a true Brazilian rosewood, however, just as there is a true mahogany, and it belongs to the genus *Dalbergia*. It is not unlikely that there is more than one species, but the evidence available indicates that at least the bulk of this timber is produced by *Dalbergia nigra* Fr. Allem., and that many of the kinds distinguished locally on account of the prevailing color—brown, purple, black, etc.—are merely individual variations due to conditions of growth, age of the trees, relative soundness, and other factors. On the other hand, there are various woods known by the common generic name of "jacarandá" which are the product of *Machaerium* and other genera of the Leguminosae and possibly, too, to other families. A thorough investigation in the field will be necessary to clear up the confusion as to the identities of these woods.

Dalbergia nigra attains a height of 125 feet or more, with a rather short, irregular, often buttressed bole, often three or four feet in diameter. The ultimate branches are fine; the leaves are pinnate with numerous small leaflets; and the pods are small, thin, and few-seeded. The trees are deciduous or nearly so. The bark is brown in color and slightly ridged and scaly. Only the heartwood is commercial and when the thick sapwood is hewn off the logs are rarely more than 18 inches in diameter. These are frequently decayed in places and it is not an uncommon practice to whip-saw the logs through the middle and hew out the defective portions. The heartwood of young trees is brown and not attractive and, in fact, it is only from the old defective trees that the highly fragrant wood with rich purplish-black marking is obtained. The natives often refer to the young second-growth timber as white rosewood ("jacarandá branca"), but investigation has shown that it is botanically the same as the species yielding the commercial timber.

The old timber in the readily accessible regions in the States of Bahia, Rio de Janeiro, Espirito Santo, and adjoining rain forests of Minas Geraes has become very scarce; but there are still considerable quantities within reach of the railroads in northern Espirito Santo, Bahia, and eastern Minas. On a tract of several thousand acres of first-growth forest in southern Bahia, believed to be fairly typical for the general

region where rosewood is found, this tree comprises only 2.2 per cent of the timber now merchantable and only 0.3 per cent of the total stand of all species.

Brazilian rosewood has been extensively used for furniture and cabinetwork, but at present there is little demand for it for these purposes in the United States, the principal use here being for spirit levels, butcher-knife handles, and to a minor extent for billiard tables and phonograph cabinets. It is probable that with changing styles in furniture there will again be a larger demand for rosewood.

THE WOOD

Dalbergia nigra Fr. Allem. *Brazilian Rosewood.*

Common names: Brazilian rosewood, palisander wood, jacaranda wood (Eng.); jacarandaholz, palisanderholz (Germ.); palissandre (Fr.); madera de palisandro (Sp.); pallissandro, legno di jacaranda (Ital.); jacarandá (various kinds), cabiúna, caviúna, jacarandá cabiúna (Braz.).

General properties: Color chocolate- or violet-brown, irregularly and conspicuously streaked with black; rather oily looking. Sapwood nearly white; sharply, but irregularly, defined.

Has a mild, but distinct, fragrant odor which gives rise to the name rosewood; very characteristic; may not be present in wood from young tree. Taste distinctive, but not definable.

Hard to heavy. Sp. gr. (air-dry) 0.85. Weight about 53 lbs. per cu. ft. Grain mostly straight; sometimes wavy. Texture medium. Wood has excellent cabinet qualities, easy to work, holds its place, is durable; some specimens too oily to take a high polish.

Growth rings: Present or absent; often distinct; when present due to differences in color or to narrow poreless zones, or to more pronounced and regular parenchyma lines.

Parenchyma: Inconspicuously about pores and in very irregular concentric and tangential lines; some continuous and apparently limiting seasonal growths, while between them are few to many irregularly spaced, broken lines, often poorly defined; sometimes visible without lens and sometimes scarcely visible with it.

Pores: Variable in size; most of them rather large and distinct; not very numerous; irregularly distributed; single or subdivided radially; round or oval in shape; mostly open.

Vessel lines: Distinct, but not conspicuous, being of about the same color as the background; mostly long. Under lens the empty vessels show distinct and regular segmentation.

Vessel contents: Dark gum deposits very common, often filling vessels completely, especially in the darker portions of the wood.

Rays: Very fine; not visible on cross and tangential sections without lens; visible, but fine and not very distinct, on radial.

Ripple marks: Present; all elements storied; fairly regular; sometimes faintly visible without lens; 125 to 130 per inch.

Gum ducts: None observed.

Remarks: Most of the other woods called "jacarandá" have much smaller pores and are not fragrantly scented. A "jacarandá" of São Paulo, which sometimes enters the New York market as Brazilian rosewood, is a coarse-textured wood with a structure not wholly unlike that of *Dalbergia nigra.* The wood is decidedly roe-grained; has a harsh feel and is not oily; the color is variegated, olive-green to carmine-red or purplish; the odor is that of walnut (*Juglans*). Those familiar with the two woods are not likely to confuse them. (*Material:* Yale Nos. 3157, 4447, 4881.)

The "jumero" of Guatemala is a small tree with 11- to 13-foliolate leaves, the leathery, stipulate leaflets often 2.5 inches long and an inch wide, with a velvety rusty pubescence below, and is undoubtedly a species of *Dalbergia.* The wood closely resembles that of *D. nigra* in structure and in color, but is not oily and has no fragrance. (*Material:* Yale Nos. 3721*, 3738.)

Material: Yale Nos. 3107, 3273*, 3301, 3302, 3303, 3308, 3486, 3508, 3509*, 3525, 4146*, 4250, 4452 (Braz.). Asterisk indicates botanical material.

COCOBOLO

Cocobolo is a Central American wood that has been used in the cutlery trade for the past 50 years. It is produced by three or four species of *Dalbergia*[102] with a combined range from southern Mexico throughout Central America, possibly into northern Colombia. The present commercial sources are Nicaragua, Costa Rica, and Panama.

True cocobolo has been confused with various other woods. It was formerly supposed, because of the similarity of the common and generic names, to be the wood of the sea grape (*Coccoloba uvifera* L.), but a comparison of the woods shows that they have almost nothing in common, either in general appearance or minute anatomy. In Peru, according to Herrera,[103] "cocobolo" is the local name for *Coccoloba nutans* Kunth. The name "cocobola" is applied in Costa Rica to *Lecythis costaricensis* Pittier, but the wood of this tree is very distinct from the cocobolo of

[102] The Panama species is *Dalbergia retusa* Hemsley. From material supplied by Messrs. E. Palazio & Company, of Corinto, Nicaragua, it appears that the ñambar legitimo" or so-called rosewood of that region is also *D. retusa.* Specimens of Costa Rican species collected by Messrs. Alberto Fait & Company, Puntarenas, have been identified as *D. hypoleuca* Pittier. It is possible that *D. lineata* Pittier, known in Salvador as "funera," also yields cocobolo in Costa Rica and Salvador, but the only evidence is Pittier's statement that the species shows a close affinity to *D. retusa.* The cocobolo or "granadillo" of Guerrero and Michoacan, Mexico, is *D. Granadillo* Pittier (= *Amerimnon Granadillo* Standley). Madagascar rosewood is sometimes sold in New York as African cocobolo. For further details see Record, S. J., and G. A. Garratt: *Cocobolo,* Bul. No. 8, Yale School of Forestry (1923).

[103] Herrera, F. L.: *Contribuçion a la flora del Departmento del Cuzco,* 1921, p. 68.

commerce. In Nicaragua a species of *Platymiscium* is called "ñambar bastardo" to distinguish it from the true "ñambar" or "ñambar legitimo" (cocobolo) which is exported as rosewood. Logs of this wood are frequently mixed in shipments of cocobolo and the material is sometimes called "yama" cocobolo on the New York market. British Guiana exports small quantities of wood under the name of broad-leaved cocobolo that is said to be a species of *Sapium*.

The true cocobolo tree grows to fairly large size on good sites, but on dry rocky hills is often small and poorly formed. The leaves bear some resemblance to those of ash (*Fraxinus*), but are alternate and the leaflets, seven to 15 in number, are not truly paired. The flowers resemble small pea blossoms and the fruits are thin, flat, smooth pods, about three inches long and one-half inch to an inch wide in the middle and constricted at each end. A pod usually contains a single seed, a small, smooth, flat red bean, but sometimes there are two or three; a small wrinkled spot, about the size of a dime, marks the location of the seed.

The woods from various countries do not exhibit greater difference than is to be noted in several specimens from the same region. Dealers profess no difficulty in distinguishing the source of a given lot of logs, but they do so through familiarity with certain features such as the size, shape, and defects of the logs, manner of hewing, etc.

Cocobolo from Panama is usually of poor form, often mere shells or split pieces with more or less of the white and worthless sapwood present, while that from farther north reaches the market in solid logs with the sapwood off. This difference is due to the fact that the primitive native methods in Panama are less efficient than in other parts of Central America where the industry is better organized. Tractors are used in parts of Costa Rica and make a decided difference in the size and quality of the logs brought out.

The sapwood is a dingy white, very sharply defined, and varying in thickness, mainly as a result of age, from about three inches in a young tree a foot in diameter to only an inch in large old trees. It is difficult to describe the color of the heartwood because it is so variable. Some pieces of it might very well be referred to as rainbow-hued, but upon exposure to sunlight and air the lighter colors lose their brilliance and merge into a deep red with a black striping or mottling. If the fresh wood is shellacked the oxidizing processes are retarded, but the brilliant hues will not last. It is often claimed that the coloring matter in cocobolo will not leach out and stain, but this is not borne out by laboratory tests. Pieces of the wood from Panama, Costa Rica, Nicaragua, and Mexico were placed in contact with wet filter paper and in every case a

Photo by C. D. Mell.

Cocobolo Tree in Costa Rica.

(Dalbergia hypoleuca.)

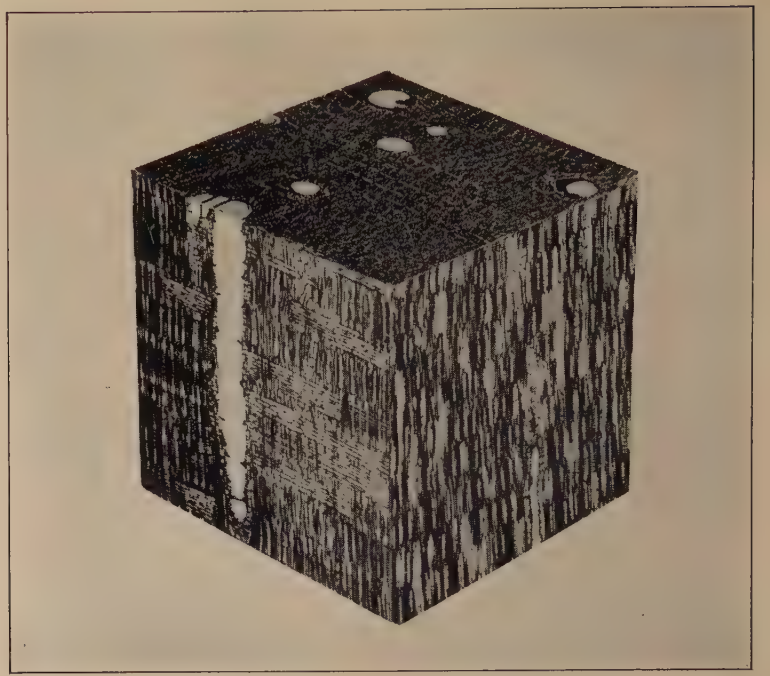


Photo by S. J. Record.

Cube of Cocobolo Wood Magnified 25 Times.

(Three photomicrographs arranged in natural positions.)

PLATE XXVIII

pronounced reddish-brown stain resulted. Water in which the wood has been soaked for several days or in which chips have been boiled assumes a peculiar yellowish color. Attempts by chemists to obtain dyestuffs and steam distillates of practical value from cocobolo sawdust have been unsuccessful.

Cocobolo is one of the most important woods in the cutlery trade, being extensively used for knife handles on account of its beauty of color and grain, fine texture, dense structure, ease of working, and the presence of an oily substance which not only tends to waterproof the wood and keep it in shape after manufacture, but also makes it very easy to polish. If the smooth surface is rubbed with a cloth it acquires a wax-like finish without the use of oil, wax, shellac, or filler. Prolonged or repeated immersing in soapy water has little effect on the wood except to darken its color, an important consideration in the case of kitchen and butcher knives. It is used also for small tool handles, brush backs, inlaying, Tunbridgeware, scales, musical and scientific instruments, launch-wheel drums, steering wheels, and for making small attachments to automobiles, launches, and expensive machinery. Some of the more beautifully figured or veined wood is manufactured into small jewelry boxes, canes, rosary beads, forks, spoons, buttons, and numerous other articles. It is unsuited for gluing.

The fine dust arising in working cocobolo may produce a rash or dermatitis resembling ivy poisoning. It may make its appearance on the fingers, forearms, face and neck, legs, or any part of the body, and is very annoying and irritating. Usually the infected employee has to discontinue work for a few days or a week and in most instances must permanently cease working in the room where he would be exposed to the dust. As in the case with poison ivy, many people are naturally immune while others are readily susceptible to the poison; and a person once infected, instead of acquiring immunity, seems to become all the more susceptible. Factories in which cocobolo has been used for years have few cases of poisoning because they gradually acquire an immune working force in that department of the plant. Recent investigations by Dr. Ettore Ciampolini of the Graduate School of Yale University indicate that the irritating principle is contained in an oil which is liberated in fine particles when the wood is worked. This principle is soluble in alkalis but precipitated by acids. The theory, which seems to be substantiated by experiment, is that workmen whose perspiration gives an acid reaction are immune, while an alkaline reaction indicates susceptibility, since the alkali dissolves the irritating agent and permits its entrance into the pores of the skin.

THE WOOD

Dalbergia retusa Hemsl. (and closely related species) *Cocobolo.*

Common names: Cocobolo or cocobola (Trade); ñambar, ñambar de agui, ñamba, nnambar, rosewood, cocobolo ñambar, cocobolo negro (C. R.); ñambar, ñambar legitimo, rosewood (Nic.); cocobolo, cocobolo prieto (Pan.); granadillo (Mex., Hond.); melón (Salv.); cocoboloholz (Germ.); red fox-wood.[104]

General properties: Color widely variable and variegated; dark red, rose, or yellowish, with veins and irregular markings of purple or black; has an oily appearance. Sapwood dingy white; sharply defined; rather thick in young trees, thin in the old ones.

Odor slightly pungent, but not fragrant; taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.99 to 1.22; (oven-dry) 0.96 to 1.17. Weight (air-dry) 62 to 76 lbs. per cu. ft. Grain variable from fairly straight to much interwoven. Texture fine and uniform. Wood turns very readily, takes a high polish, holds its place after drying, is highly durable; has an oily feel.

Growth rings: Present, but not always distinct without lens. Due to slight differences in density and to fine line of terminal parenchyma. The deeply colored layers are irregular and independent of the growth rings.

Parenchyma: In very numerous, very fine and closely spaced lines, sometimes continuous and concentric, but more often interrupted, producing irregular lines or fine network; lines are of about the same width as the rays and not visible without lens.

Pores: Small to fairly large; visible without lens; rather few and very irregularly scattered; mostly filled with lustrous gum.

Vessel lines: Few; distinct, but not conspicuous, though fairly prominent in light-colored wood, being darker than background; mostly short and irregular.

Vessel contents: Gum deposits common; tyloses absent or rare.

Rays: Extremely fine; invisible without lens on cross and tangential sections and not very distinct with it; barely visible on radial.

Ripple marks: Present; very fine and fairly uniform; faintly visible without lens; 110 to 150 per inch; all elements storied.

Remarks: Cocobolo is readily distinguished from other woods of *Dalbergia* by the very numerous, fine, and closely spaced lines of parenchyma.

Material: Yale Nos. 2094*, 4090, 4323, 4466 (Pan.); 4467, 4776, 5344*, 5887 (C. R.); 4468, 4469, 4775, 5232, 5891 (Nic.); 95, 131 (Hond.); 4410*, 5243*, 5250* (Mex.). Asterisk indicates botanical material.

[104] Authority for this name is contained in a letter of September 21, 1921, from Mr. Alexander L. Howard, of London, who says: "I find upon enquiry that cocobolo, which has been on the market for many years, was known about 40 years ago as 'red fox-wood.'"

HONDURAS ROSEWOOD

Honduras rosewood is supplied by one or more species of *Dalbergia* in southern British Honduras. The following information concerning it is furnished by Mr. W. N. Bourne of Punta Gorda: "The tree grows mostly on broken ridges along the coast, but is also found in fairly large quantities inland on strips some two miles wide on either side of the rivers. Timber of good quality is limited to the southern part of the colony. The trees attain fairly large dimensions and diameters of 30 to 36 inches are not uncommon. Three varieties are recognized, namely, light-coloured, brown, and dark brown or almost black; the experienced bushman is able to distinguish them by the appearance of the bark of the standing trees. In preparing the timber for market, the trees, after felling, are hewn free of sapwood and the remaining heart portion is cut into lengths of four to six feet and made as nearly cylindrical as possible. Roads are then opened up and the logs are loaded on wooden slides and hauled by cattle to the banks of navigable streams. The wood is weighed there and subsequently shipped by boat to Belize for transshipment to the United States and Europe." The annual exports amount to about 100 tons.

The Honduras rosewood has been an article of trade for many years, but the species producing it has yet to be determined. Mr. Bourne supplied the authors with wood specimens and leaves from the same tree, and while the latter indicate a close affinity to cocobolo, fertile botanical material will be necessary to decide the species.

The principal use for the wood in the United States is for the bars of percussion instruments, such as xylophones and marimbas, for which it seems peculiarly fitted because of its density and resonance. Brazilian rosewood was formerly employed for this purpose, but was found too soft to withstand the impact of the player's mallets, and for this reason some manufacturers of such instruments avoid the use of the name rosewood in descriptions of their product. In making the bars, the logs are cut into quarters, then into edge-grain planks one inch thick, and from these the bar blanks of varying length are sawn. The blanks are ordinarily air-seasoned under cover for from two to seven years. There is considerable loss due to season checks and other defects as well as in manufacture, so that the weight of the finished bars represents only from 20 to 30 per cent of the weight of the logs.

THE WOOD

Dalbergia sp. *Honduras Rosewood.*

Common names: Honduras rosewood, nagaed wood (Trade).

General properties: Color dull brownish to purplish with dark lines or

streaks. Sapwood gray; sharply defined; about one inch thick in mature trees.

Without characteristic taste and nearly odorless; freshly worked material slightly fragrant.

Wood hard and heavy. Sp. gr. (air-dry) 0.93 to 1.08. Weight 58 to 68 lbs. per cu. ft. Grain mostly straight. Texture somewhat coarse. Wood tough and strong, not difficult to work, finishes smoothly, but does not take a high natural polish, holds its shape well when thoroughly seasoned; is not oily or waxy; appears highly durable.

Growth rings: Present; due to terminal parenchyma line; not distinct without lens. False growth rings, due to the narrow deeply colored zones, are very distinct, but upon close inspection are found to be more or less independent of the true growth rings.

Parenchyma: In terminal line usually visible without lens; also in narrow circles about pores and in numerous, usually irregular, tangential to concentric lines, distinct under lens; much variation noted in different specimens, also in different rings of same one; lines coarser than in cocobolo.

Pores: Varying from rather large to small; usually readily visible; few and irregularly scattered to fairly numerous; mostly solitary, but sometimes subdivided radially; local tendency to ring-porous structure occasionally observed.

Vessel lines: Readily visible; usually darker than background, due to dark-colored contents.

Vessel contents: Gum deposits abundant.

Rays: Very fine; at limit of vision on cross section; invisible on tangential; low and inconspicuous on radial surface, where they appear darker than background.

Ripple marks: Present; all elements storied; faintly visible; regular or fairly so; number per inch, 112 to 137, average 120.

Gum ducts: None observed.

Remarks: The arrangement of the parenchyma suggests Brazilian rosewood rather than cocobolo. The wood is readily distinguished from the latter by the color and low luster, and from the former by the lack of pronounced scent and also through the fact that the dark-colored zones are comparatively straight and uniform.

Material: Yale Nos. 4978, 6589 (with leaves), 6340, 6590, 6591, 6592 (B. Hond.).

MACHAERIUM

This genus consists of about 80 species of trees and shrubs rather widely distributed in tropical America, especially in Brazil. There is an unfortunate dearth of information and authentic material in respect to this genus, which is credited with supplying some of the Brazilian rosewood of commerce, locally known as "jacarandá" of various kinds, such as "tan," "preta," "do matto," "roxa," "bico de pato," etc. Some of these names are also applied to *Dalbergia nigra* Fr. Allem., the true

rosewood of Brazil, and to trees of other genera. Judging from the specimens of the "jacarandá" supposed to belong to the genus *Machaerium*, the wood is of a variegated brown and purple color, fine-textured, roe-grained, hard, heavy, and compact, with numerous barely visible small pores, parenchyma mostly confined to narrow concentric lines limiting the growth rings, and with narrow rays, and fine and regular ripple marks.

The tiger wood of the Guianas is a medium-sized tree, said to be *Machaerium Schomburgkii* Benth., yielding a fine-textured, satiny wood, of the color of walnut and used to some extent for cabinet work, inlaying, paneling, and walking sticks. There are no specimens of this wood in the Yale collections, but from the descriptions that various writers give of it there is reason to doubt if it has been correctly identified. The common names are: Tiger wood, itaka, itiki, itikiboura, itikiboura-balli, itikitibouraballi, hitriribouraballi (B. G.); bois de lettres marbré, bois de lettres moucheté, bois de lettres tigré (Fr. G.).

The only authentic specimens of *Machaerium* in the Yale collections are from the type tree of *M. Whitfordii* Macbride, collected by Whitford in the forest along the Negro River in Colombia, where it is a fairly common, medium-sized tree, with a dark-colored heartwood of commercial importance, and known locally as "negrillo." It has pinnate leaves with numerous small leaflets; the fruits are velvety winged pods over ten inches long with the seed at one end.

THE WOOD

Machaerium Whitfordii Macbride *Negrillo.*

Common names: Negrillo (Col.).

General properties: Color chocolate-brown to black, more or less variegated and streaked; lustrous. Sapwood cream-colored; sharply, but irregularly, defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (oven-dry) 0.975 (sapwood) to 1.12 (heartwood). Weight 60 to 70 lbs. per cu. ft. Grain roey. Texture fine. Wood tough, strong, splintery, not very difficult to work, takes a high glossy polish, appears very durable.

Growth rings: Present; due to concentric lines of parenchyma.

Parenchyma: In narrow inconspicuous circles about pores and in concentric lines apparently limiting seasonal growths, and sometimes dividing into two or three lines for varying distances; irregularly spaced; visible, but not very distinct in heartwood.

Pores: Small, barely visible; fairly numerous, but not crowded; well distributed; occurring singly or in small radial groups; sometimes tending to form diagonal rows; mostly open.

Vessel lines: Fine and inconspicuous.

Vessel contents: Dark-colored gum common; tyloses absent.

Rays: Not visible without lens on cross and tangential sections; visible, but very fine and scarcely distinct, on radial surface.

Ripple marks: Present; all elements storied; regular; faintly visible without lens; number per inch, 140 to 145.

Gum ducts: None observed.

Remarks: For more detailed description see MILLER, ROBERT B.: The wood of *Machaerium Whitfordii* Macbride, *Bul. Torrey Bot. Club,* 47: 2: 73-79, Feb., 1920.

The "chapulaltapa" or "palo de carretas" of Mexico is said to be *Machaerium latifolium* (Benth.) Pittier.

Material: Yale No. 415 from type tree of species described by J. Francis Macbride in *Cont. Gray. Herb.* (n. s.) 56: 53, Dec., 1918.

TULIP WOOD

One of the best known Brazilian cabinet woods is the "sebastião de arruda," called tulip wood in the trade. The exact botanical status of this timber is unknown, though there is general, but mistaken, belief that it is produced by *Physocalymma scaberimmum* Pohl (Lythraceae). Its inclusion in the Leguminosae is based entirely on the structure of the wood.

The tree grows in the dry interior forests of northeastern Brazil and the timber is brought by rail to Bahia, the chief port of shipment for that region. It is in the form of short, hewn logs mostly under six feet in length and from six to twelve inches in diameter, free of sapwood. It is used in furniture making and cabinet work, particularly for inlays. It is a comparatively rare wood and the amount used is small.

THE WOOD

(Undetermined) ***Tulip Wood.***

Common names: Tulip wood, rosewood (Trade); sebastião de arruda, páo rosa, grão de porco ?, cego machado or maschado ? (Braz.); brazilianisches rozenholz, tulpenholz (Germ.); bois de rose (Fr.).

General properties: Color variable from yellowish with red or purplish striping and markings to deep rose red with a mingling of lighter shades and colors; a beautiful wood with very distinctive coloration. Sapwood pale yellow or nearly white.

Fragrantly scented. Taste somewhat acrid.

Hard and heavy. Sp. gr. (air-dry) 1.03. Weight about 63 lbs. per cu. ft. Grain straight or fairly roey. Texture rather fine. Wood takes high polish, turns smoothly, has good cabinet qualities.

Growth rings: Present; limited by fine line of parenchyma; sometimes there is a tendency to ring-porous structure.

Parenchyma: Inconspicuously about pores, sometimes wing-like and confluent; also in occasional fine tangential or concentric lines; especially at or near the periphery of the growth rings; considerable variation in different rings.

Pores: Variable from moderately large and distinct to very fine and invisible without lens; larger pores occasionally in short tangential rows at beginning of growth ring; small pores solitary or subdivided radially; varying in number from numerous to comparatively few. In some instances there is a gradual diminution in size of the pores toward the outer part of the ring.

Vessel lines: Largest distinct, but not conspicuous; often in groups on tangential surface; mostly long and finely wavy.

Vessel contents: Some deposits of green and white substance noted. Tyloses scanty.

Rays: Invisible or at limit of vision on cross section; scarcely visible on tangential with lens; visible, but fine and inconspicuous, on the radial surface, where they are usually darker than background.

Ripple marks: Present; all elements storied; scarcely visible without lens and are due mostly to lighter-colored lines between ray tiers; regular or fairly so; number per inch, 160 to 165.

Remarks: A study of an authentic specimen of the wood of *Physocalymma scaberrimum* confirmed the conclusion previously reached by one of the authors[105] that the Brazilian tulip wood did not belong to the Lythraceae. Efforts to obtain botanical material of the tulip wood have so far been unsuccessful.

Some specimens of tulip wood have a superficial resemblance to the "satiné" of French Guiana and the "bubinga" of western Africa, but the structure is so different that there is no occasion for confusion.

Material: Yale Nos. 2070, 3379, 3517, 3530, 3584, 4300, 4446 (Braz.).

TIPUANA

Of the four species of this genus, the best known is the "tipa" of Argentina, *Tipuana speciosa* Benth., which occurs principally in the tropical or sub-tropical forest on the lower slopes of the Andes in the Provinces of Tucuman and Jujuy. It attains a height of over 100 feet, and the somewhat buttressed trunks are not infrequently three feet in diameter and free of limbs for 30 or 40 feet. The tree is deciduous, and in the vicinity of Buenos Aires drops its pinnate leaves late in April or in May and remains bare during the winter season. The bright yellow flowers are borne in small clusters in great profusion and appear with or shortly after the new leaves. The winged fruits, which resemble those of maple (*Acer*), remain on the tree most of the year and are often so abundant that they carpet the ground when they fall.

[105] See Record, S. J.: Storied or tier-like structure of certain dicotyledonous woods, *Bul. Torrey Bot. Club,* 46: 260, July, 1919.

The trees occur scatteringly in the forest, usually along the water courses, and rarely average over one or two per acre. The timber reaches the market in the form of square-hewn logs and is fairly common in Tucuman, but rare in Buenos Aires because of the long haul by rail. It is well known and much appreciated for furniture and cabinetwork and is also used in the construction of vehicles and railway cars. The leaves are employed in veterinary medicine and the bark serves locally for tanning and dyeing. The tree lends itself readily to cultivation and is planted extensively for decorative purposes, being very common along the streets and in the parks of Buenos Aires; it has also been introduced into France, Algeria, and warmer portions of the United States.

THE WOOD

Tipuana speciosa Benth. *Tipa.*

Common names: Tipa, tipa blanca, tipa amarella ? (Arg.); tipuana (Braz.).

General properties: Color nearly white to yellow; sometimes with roseate hue; finely striped with vessel lines, often dark-colored; suggests ash (*Fraxinus*). Sapwood poorly defined.

Odor and taste absent or not distinctive.

Of medium weight and density. Sp. gr. (air-dry) 0.65. Weight about 40 lbs. per cu. ft. Grain finely roey. Texture medium. Wood strong, somewhat difficult to work, takes a smooth and lustrous finish; does not appear durable.

Growth rings: Fairly distinct; due to differences in size of the pores also to fine line of parenchyma.

Parenchyma: About pores in wing-like processes which may unite into short to long wavy lines in early wood, and into continuous, less wavy, concentric ones in the late wood; visible and fairly distinct.

Pores: Those in early wood rather large; approaching ring-porous. Those in late wood small to minute; fairly numerous; well distributed; occurring singly, subdivided, or clustered.

Vessel lines: Distinct to conspicuous; mostly short, due to cross grain; coarse.

Vessel contents: Dark gum common.

Rays: Very fine; not visible on cross and tangential sections; visible, but inconspicuous, on radial surface.

Ripple marks: Present; all elements storied; barely visible; fairly regular; number per inch, 120 to 135.

Gum ducts: None observed.

Material: Yale Nos. 897, 906, 1107, 4380, 5298, 6223 (Arg.).

PLATYPODIUM

This genus consists of three species of trees, two of which are Brazilian, the other occurring in Panama and Colombia. Of the Brazilian

species the better known is *Platypodium elegans* Vog., a small or medium-sized tree, common on the plateau in the interior of São Paulo, and known as "jacarandá do campo" or "jacarandá branco." The wood is said to be hard and heavy (sp. gr. 0.76 to 0.91), of a light-brown color with areas of darker brown, and used for carpentry, joinery, and miscellaneous purposes. There are no authentic specimens of this wood in the Yale collections.

P. Maxonianum Pittier is a tree 65 to 80 feet high with a trunk sometimes four feet in diameter, occurring frequently and sometimes gregariously in the lower forest belt on the littoral plains of Panama, where it is known as "carcuera," and in northern Colombia, where it is called "lomo de caiman." The leaves are compound, with 10 to 20 rather large leathery leaflets; the fruit is a narrow, samara-like pod between four and five inches long, with a single seed at one end. The mature trunks are commonly hollow and are said to be filled with an oily liquid. The wood is little used.

THE WOOD

Platypodium Maxonianum Pittier *Carcuera.*

Common names: Carcuera (Pan.); lomo de caiman (Col.); flat-pod tree.

General properties: Color of sapwood light greenish-yellow; lustrous. Heartwood unknown. May be a "sapwood" tree.

Odor and taste absent or not distinctive.

Moderately hard and heavy. Grain somewhat roey. Texture rather fine. Wood tough, strong, fairly easy to cut, takes a high polish, does not appear durable.

Growth rings: Fairly distinct, due to zones deficient in parenchyma lines.

Parenchyma: In numerous fine, inconspicuous, wavy, concentric lines, crowded in places and widely spaced in others; not about pores.

Pores: Small; faintly visible; fairly numerous; irregularly disposed; occurring singly or in radial rows of two to several pores each; open.

Vessel lines: Fine and inconspicuous.

Vessel contents: None observed.

Rays: Very fine; not visible on cross and tangential sections, and scarcely distinct on radial surface.

Ripple marks: Present; very regular; all elements storied; faintly visible without lens; number per inch, 105 to 115.

Material: Yale No. 2990 collected by Pittier in Panama; his No. 5229.

CENTROLOBIUM

This genus consists of five tropical American species, namely, the "amarillo de Guayaquil" of Ecuador, *Centrolobium ochroxylon* Rose.,

the "amarillo de Guayaquil" of Panama, *C. patinense* Pittier, the "araribá" or "putumuju" of Brazil, *C. robustum* Mart. and *C. tomentosum* Guill., and the "muiracoatiára" or "páo de rainha" of the Amazon region, *C. paraënse* Tul. This last species is said to occur in other parts of South America and may be the "cartan" or "balaustre" of Venezuela, one of the "putumujus" of Bahia, and the source of some of the wood known as zebra wood or porcupine wood[106] in the trade. The trees have compound leaves with large to very large leaflets arranged alternately or oppositely along the petioles. Most characteristic of all is the fruit, which looks like a chestnut bur with the wing of a gigantic maple seed attached to it.

All of the woods of *Centrolobium* appear to have distinct growth rings due to differences in density and color. Parenchyma is developed about the pores in varying amount, but is rarely distinct. The pores vary in different specimens from small to large, and from very numerous and crowded to rather few and scattered, often with lustrous contents. The vessel lines are usually ruby-colored, due to gum; this gum sometimes exudes. The rays are very fine and visible only on the radial surface. Ripple marks are present, all elements storied, regular, faintly visible without lens, 100 to 120 per inch.

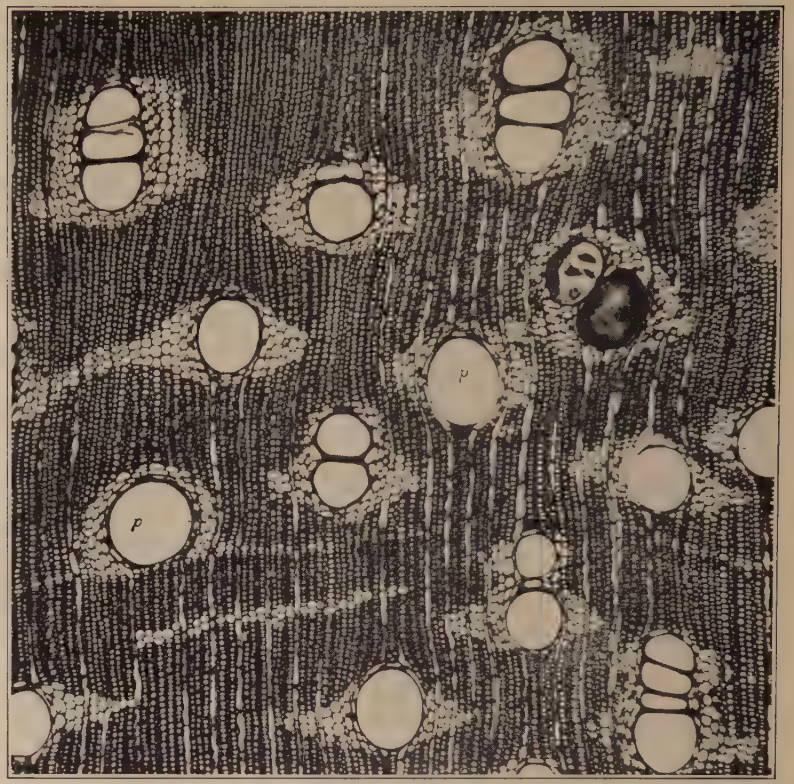
THE "AMARILLO DE GUAYAQUIL" GROUP

Although the woods of *Centrolobium* are separable into fairly well-defined groups, the available information and material are not sufficient to refer them to species except in the case of Panama and Ecuador. Both kinds of "amarillo de Guayaquil" are hard and heavy, and, when fresh, of a brilliant orange color with purplish streaks, soon turning to a dark mahogany-red on the surface. The fresh wood bears considerable resemblance to the brazilwood or Pernambuco wood (*Caesalpinia echinata*). To this group belong the following specimens in the Yale collections: "Cartan" (Nos. 335, 4431, and 6650) and "balaustre" (No. 2758) of Venezuela; porcupine wood or zebra wood (No. 4454) from a tree planted in Trinidad and supposed to be *C. paraense;* "putumuju" and "putumuju vermelha" (Nos. 3378 and 3540) of Bahia, and "araribá testa de boi" (No. 3206) of Espirito Santo, Brazil, the latter wood prominently streaked with black. The woods of this group exhibit some variation in texture and in density as well as in the abundance and arrangement of their pores, but in general they are very much alike and are readily separable from all of the others by the richness of their coloring. They have excellent cabinet qualities and are well suited for

[106] This name is in allusion to the spiny fruits.

Photo by H. Pittier.

Fruits of Amarillo de Guayaquil (x ½).
(*Centrolobium patinense.*)



Photomicrograph of the Quira of Panama (x 50).
(*Platymiscium dubium.*)

PLATE XXIX

the manufacture of fine furniture and interiors of railway parlor and sleeping cars. The trees attain rather large size, but apparently are nowhere abundant.

THE "ARARIBÁ" OR "PUTUMUJU" GROUP

"Araribá"[107] is the generic common name in the markets of Rio de Janeiro and São Paulo for the various woods of the genus *Centrolobium.* The kinds commonly recognized are "amarella," "branca," "rosa," and "vermelha." The names "araúva" and "ararobá" are also applied to these woods. In Bahia they are more commonly known as "putumuju," with various specific designations. Some of the "putumujus" belong in the preceding group, but the more common kinds are like those further south and bear no resemblance to the brazilwood of commerce.

The prevailing color is yellow in various shades, often variegated with red or black, and usually with blood-red vessel lines. The sapwood is white and sharply defined. Some specimens are comparatively light, others are heavy and hard. The texture is rather fine and the woods are easy to work and take a high satiny polish. The wood splits readily and, when worked against the grain, is likely to tear out in long thin slivers. Some of the kinds are highly durable and make good railway ties and are generally useful in outdoor construction; others serve best for carpentry and interior work. Other common uses are cooperage, flooring, furniture, interior finish, and shipbuilding. "Putumuju" was exported to France in considerable quantities before the war and was employed in the form of veneers in the manufacture of furniture, piano cases, and panels. The trees are common and of good dimensions in Brazil and the timber is well known in all the larger markets there.

The "araribá" of southern Brazil finds a counterpart in Colombia in a wood or group of woods known as "guayacan jobo." Some of the specimens are hard and heavy, rather fine-textured, and not prominently colored, while others are coarser, lighter, and rainbow-hued. One "batteo" of Panama may belong to this group.

Material: Yale Nos. 681, 697, 1464, 1788, 2074, 2492, 3123, 3124, 3125, 3206, 3207, 3231, 3269*, 3378, 3425, 3468, 3522, 3540, 3593A*, 4237, 4280, 4281, 4712, 4278 (Braz.); 2095* (Pan.); 4438* (Ec.); 419*, 1603, 2588 (Col.); 335, 2758, 4431, 6650 (Venez.). Asterisk indicates botanical material.

PTEROCARPUS

This genus consists of over 60 species widely distributed throughout the tropics of both hemispheres, of which about one-third are tropical

[107] "Araribá" should not be confused with "arariba" (*Pinckneya rubescens* Fr. Allem. & Sald.).

American. A few of the species of the Old World yield some of the most valuable cabinet woods of commerce, among which are the "narra" of the Philippines; padauk of the Andaman Islands, Burma, and Africa; the red sanders of India; the African rosewood and Burmese rosewood and vermilion.[108] Some of the woods are valuable as sources of dyes and also of gum resins of medicinal value. The woods of the tropical American species are, so far as known, white or light-colored and are used only locally.

The tropical American species vary in size from little trees only 20 feet high to some of the largest trees of the forest. Some of them grow in wet lands along the coast, while others are found only in the uplands. They do not supply timber for the market. The leaves are pinnate with a few large leaflets; the flowers are large and mostly yellow; the pods are flat, short, and broad, containing only one or two seeds, and do not open. One of the most distinctive features is that when the bark is cut it exudes a blood-red juice that soon hardens into a dark resin without odor or pronounced taste. It was formerly used in medicine under the name of "dragon's blood" and it shipped in considerable amount from Cartagena, Colombia, to Spain.

The best known and most widely distributed species is usually referred to as *Pterocarpus Draco* L., though some of the forms originally covered by this name are now recognized as distinct species. It appears to be confined to the lowlands, and in northern South America frequently forms dense pure stands over considerable areas in the coastal regions back of the mangrove (*Rhizophora*) swamps. The trees often reach large size and the wood seems to be softer than that of the upland forms, and in British Guiana is known as corkwood. It is said to be used by the natives as floats for fish nets, though the wood most commonly used for this purpose is *Anona palustris* L.

There are several species in the Amazon region and those of the swamps, including *P. Draco*, are called "mututy," while an upland species, *P. Rohrii* Vahl, is known as "mututy da terra firme" and probably corresponds to the "moutouchi grand bois" of French Guiana, according to Huber.[109]

There is a species known as "páo sangue" in the rain forests of Bahia and Espirito Santo, where it occurs in small groups or as scattered individuals, often averaging three to five per acre. It reaches a height of 100 to 125 feet and has an irregular and buttressed bole often 10 to 15 feet through the buttresses and six feet in diameter above them. The bark is thin, yellowish, and flaky and has the characteristic blood-red

[108] Some of these names are synonyms.

[109] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus Goeldi*, 6: 183 (1909).

sap. The crown is much branched and spreading and suggests that of elm (*Ulmus*), and the leaves have usually seven alternate leaflets that are sometimes five inches long and two inches wide and are smooth, leathery, and entire.

The wood is normally of a yellowish-white color throughout, but following injury from boring insects and other causes there are local discolorations varying in color from dark red to green. There is a very noticeable difference in the density of the wood from different parts of a large tree, being comparatively hard and tough toward the outside of the log and soft and brashy in the interior. A variety, or possibly a different species, known locally as "angú," is said to yield better wood than the "páo sangue." The timber is well known in the rural districts and is used for a great many purposes where a soft and easily worked wood is desired in places not exposed to decay or termites.

THE WOOD

Pterocarpus spp. *Bloodwood.*

Common names: Bloodwood, swamp bloodwood (Eng.); palo pollo, palo de pollo (P. R.); bois l'étang, lagunero (Trin.); bois de corail tendre, bois chatousieux (Guad.); moutouchi, moutouchi grand bois, moutouchi de savane, palétuvier, liège du pays (Fr. G.); bébé, bébé hoedoe (Sur.); corkwood, itchiki-boura, itik-boura, mutushi, warau, hiburu (B. G.); sangre de drago, haro, lagunero (Venez.); sangre drago (Col.); mututy, mututy da varzea, mututy da terra firma, páo sangue, angú, tachyzeiro (Braz.); ibirá-rá, ybirá-rá (Arg.); sangre-drago, sangre de drago (C. A.); drago, sangre de drago, sangre-drago, guayabillo, llora-sangre (Mex.).

General properties: Color white or whitish; dull to lustrous; sometimes with greenish or dark red areas due to injury. No distinction in color between heart and sap.

Odor and taste absent or not distinctive.

Very soft and light to moderately hard. Grain fairly straight. Texture rather fine. Cuts easily, finishes smoothly, is not durable.

Growth rings: Present, due to fine line of limiting parenchyma, and sometimes to slight differences in density and color.

Parenchyma: In fine concentric lines, rather closely and uniformly spaced, or with part of the lines broken, wavy, and anastomosing; distinct on cross section and sometimes on the tangential, especially when darker than background; not much parenchyma about pores.

Pores: Small to minute; not very numerous; often larger and more numerous in inner portion of ring; the larger pores are readily visible.

Vessel lines: Narrow and straight or slightly wavy; sometimes conspicuous on account of dark contents.

Vessel contents: Dark red or brown substance sometimes present and conspicuous.

Rays: Very fine, not visible without lens on cross and tangential sections; visible, but fine and inconspicuous, on radial surface, where they are of about the same color as the background.

Ripple marks: Present; usually visible without lens; all elements storied; fairly regular; 120 to 125 per inch.

Gum ducts: None observed.

Remarks: The structure and appearance of the woods of various tropical American species do not show much variation. The principal difference noted is in the density, which varies considerably in the same tree.

Material: Yale Nos. 1938, 3215, 3564, 3954*, 4673* (Braz.); 431 (Col.); 4094* (Venez.). Asterisk indicates botanical material.

PLATYMISCIUM

This genus consists of about 25 species of shrubs and trees widely distributed throughout continental tropical America. The leaves are opposite or whorled, imparipinnate, with three to seven leaflets, opposite and large. The flowers are yellow and the pods are flat and do not open. The woods are hard and heavy, but of cabinet properties, and have a reddish color often variegated with purple. Although some of them are known to the trade they have never been extensively used.

There are several species of *Platymiscium* in the Amazon region where they are commonly known as "macacaúba." Huber[110] says that the "macacaúba" seems to be fairly abundant in certain districts and will probably be used extensively in future for cabinetwork and furniture in place of mahogany. The species on the upland at the mouth of the Teffé is *P. Duckei* Huber, while that of the lower Amazon is *P. paraënse* Huber and probably others. The woods, however, are practically identical and are of a bright red color with fine stripes of dark red or purple, giving a beautiful effect.

This wood has no distinct growth rings, though the bands of darker color are often regular enough to give the appearance of seasonal growths. Parenchyma is in narrow circles or diamond-shaped patches about the pores and occasionally in short tangential lines. The pores are rather large, distinct, numerous, but not crowded, well distributed, mostly solitary, but sometimes subdivided. The rays are very fine, invisible on cross and tangential sections and scarcely distinct on the radial. Ripple marks are present, rather irregular, faintly visible, all elements storied; number per inch, 90 to 100. *Material:* Yale Nos. 1431, 3933.

Shipments of cocobolo (*Dalbergia*) from Nicaragua frequently contain logs of another kind of wood which the New York dealers call bastard cocobolo, "yama" cocobolo or "yama" rosewood, and which the

[110] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 182 (1909).

exporters refer to as "ñambar bastardo" to distinguish it from the "ñambar legitimo," the true cocobolo. From leaf specimens supplied by Messrs. E. Palazio & Company, of Corinto, this has been identified as *Platymiscium trifoliatum* Benth. The leaflets are membranous, elliptical with a pointed tip, and large, the terminal ones being sometimes five inches long and three inches wide. The wood is of a dark reddish color variegated with lighter and darker shades, sometimes appearing brick-red with irregular black markings. The specific gravity, air-dry, of one specimen was found to be 1.05; oven-dry, 0.99; moisture content 6 per cent. Ripple marks are present, fairly regular, faintly visible, the number per inch varying from 100 to 115, average 110. The structure is much the same as that of the "quira" of Panama. (Plate XXIX.)

The best known and most widely distributed species is *Platymiscium polystachyum* Benth., which occurs in the dry forests of northern Venezuela and Colombia and in the foothills of the Pacific coast of Panama and Nicaragua. It is a medium-sized, short-boled, deciduous tree with a rounded crown. The leaves are opposite or in whorls of three, the leaflets large and mostly five to a leaf. The tree is known as "quira" in Panama, a name also applied to *P. dubium* Pittier, and the timber is usually called Panama redwood in the trade. The Venezuelan name is "roble colorado," and logs five to seven feet long and from three to four feet in diameter are exported occasionally from the Lake Maracaibo region. The wood is employed locally in furniture and cabinetwork, but its principal use in the United States is for billiard cue butts and as a substitute for cocobolo in making tool handles. Some of the heavy timbers in the National Palace of Panama are of this wood and a recent renovation of this structure showed that the wood was in perfect condition.

THE WOOD

Platymiscium polystachyum Benth. *Quira.*

Common names: Quira, sinkra, zrok (Pan.); aceituno montes, granadillo (Salv.); roble (Trin.); roble, roble colorado, roble blanco (Venez.); trebo (Col.); Panama redwood, vencola (Trade). Other species: Subinché (Mex.); mulatto, hormigo, ormigo (Guat.-Hond.); ñambar bastardo (Nic.); quira (Pan.); macacaúba, macacaúba da varzea, macacaúba da terra firma, moira-caoba (Braz.).

General properties: Color rich red or reddish-brown, uniform or with lighter and darker veining; lustrous. Sapwood thick, yellowish-white; rather sharply defined.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (oven-dry) about 1.00. Weight about 62 lbs. per cu. ft. Grain roey. Texture rather fine. Not very difficult to work, finishes smoothly and takes a high polish, holds its place well, is highly durable.

Growth rings: Scarcely distinct without lens; limited usually by very fine line of parenchyma.

Parenchyma: In distinct circular, elliptical, diamond-shaped, wing-like patches about the pores and sometimes connecting them irregularly; also in fine concentric lines apparently limiting seasonal growths.

Pores: Rather small, but readily visible and appearing very distinct because of parenchyma about them; numerous, but not crowded; well distributed; mostly round and solitary, but sometimes subdivided; open or closed with gum.

Vessel lines: Distinct, but not conspicuous; usually darker than background.

Vessel contents: Dark-colored gum deposits common.

Rays: Invisible on cross and tangential sections; visible, but very low, uniform and scarcely distinct on radial surface where they appear darker than background.

Ripple marks: Present; fairly regular; all elements storied; faintly visible without lens; number per inch, 95 to 105.

Gum ducts: None observed.

Remarks: The "hormigo" or "mulatto" of Guatemala-Honduras (Yale No. 3672), provisionally identified from the leaves as this species, has a light reddish color and narrow purplish stripes suggesting the "macacaúba." The wood is not as dense as the "quira."

Material: Yale Nos. 2991*, 4328, 4977 (Pan.); 6627 (Hond.); 404* (Col.); 6588, 6655 (Venez.). Asterisk indicates botanical material.

ICHTHYOMETHIA (PISCIDIA)

This genus consists of seven or eight species of trees or shrubs found in the West Indies, southern Florida, Central America, and southern Mexico. The best known species is the Jamaica dogwood, *Ichthyomethia piscipula* Hitch. (= *Erythrina piscipula* L. = *Piscidia Erythrina* L. =*Piscidia piscipula* Sarg.), one of the commonest tropical trees in southern Florida, on many of the Antilles, and in southern Mexico.[111] It is a tree 40 to 80 feet high with a trunk often over two feet in diameter. The leaves suggest those of the white ash (*Fraxinus americana*), the pea-like flowers are white tinged with red, and the four-winged, indehiscent pods are three or four inches long and an inch or more wide across the longitudinal wings.

Standley[112] states in regard to *I. communis*, whose properties he considers probably common to all or most of the species: "The wood is very

[111] According to S. F. Blake (*Journ. Wash. Acad. Sci.*, 9:247, 1919), this species is confined apparently to Jamaica, the one occurring in Florida, Mexico, and Guatemala being *I. communis* Blake.

[112] Standley, Paul C.: Trees and shrubs of Mexico, *Cont. U. S. Nat. Herb.*, 23: 2:511 (1922).

durable, especially in water, and takes a fine polish. It has been used for boat building, fuel, and charcoal. Robelo states that in Mexico there is a popular belief that the wood petrifies after many years, beginning at the heart. The dry bark, especially that of the root, has a strong and disagreeable odor of opium; it produces a burning sensation in the mouth. It contains substances (one of which has been named piscidin) which are narcotic and analgesic, and has been used as an anodyne in neuralgia, nervous insomnia, whooping cough, etc. The extract of the bark is sometimes employed in tropical America for relieving toothache, applied locally, and that of the Jamaican species to cure mange in dogs. The best-known use of the tree, however, is its employment for poisoning or stupefying fish, the bark and leaves being crushed and thrown into the water. It is said that the Caribs used the juice for poisoning their arrows, but this appears doubtful."

Other uses of the wood are piling, posts, felloes of wheels, and frames of vehicles.

THE WOOD

Ichthyomethia piscipula (L.) Hitch. *Jamaica Dogwood.*

Common names: Jamaica dogwood (U. S.); fish-poison, dogwood (Bah.); dogwood (Jam.); ventura (P. R.); guamá hediondo (Cuba); bois à énivrer (Guad.); barbasco de árbol (Col.); barbasco (Venez.); chijol, cocuite, flor de papagallo, haabí, haabín, habí, javín (Mex.). Other species: Cocuile, colorín de peces, matapez, palo blanco, tatzungo, zatzumbo (Mex.); palo de zope (Salv.); bitch wood.

General properties: Color yellowish-brown; lustrous. Sapwood gray, fairly distinct, but not very sharply defined.

Hard and heavy. Sp. gr. (oven-dry) 0.87 (Tenth Census). Weight about 54 lbs. per cu. ft. Grain finely roey. Texture medium. Wood rather difficult to work, takes a high polish, is very strong and durable.

Growth rings: Poorly defined; sometimes indicated by finer and more regular line of parenchyma.

Parenchyma: Abundantly developed in numerous, irregular, wavy bands which include the pores; very distinct on cross section and produces fine pattern on the tangential; also in occasional fine lines independent of the pores.

Pores: Of medium size; distinct; few and irregularly scattered; mostly solitary, sometimes subdivided; mostly open.

Vessel lines: Rather few; distinct; darker than background.

Vessel contents: Dark-colored gum deposits common.

Rays: Very fine; near limit of vision on cross and tangential sections; low and inconspicuous on the radial surface, appearing of same color as background.

Ripple marks: Present; many of the rays occupying more than one story; not distinct without lens; 140 to 150 per inch.

Material: Yale No. 5231A (Florida); 6169 (Mex.).

ANDIRA

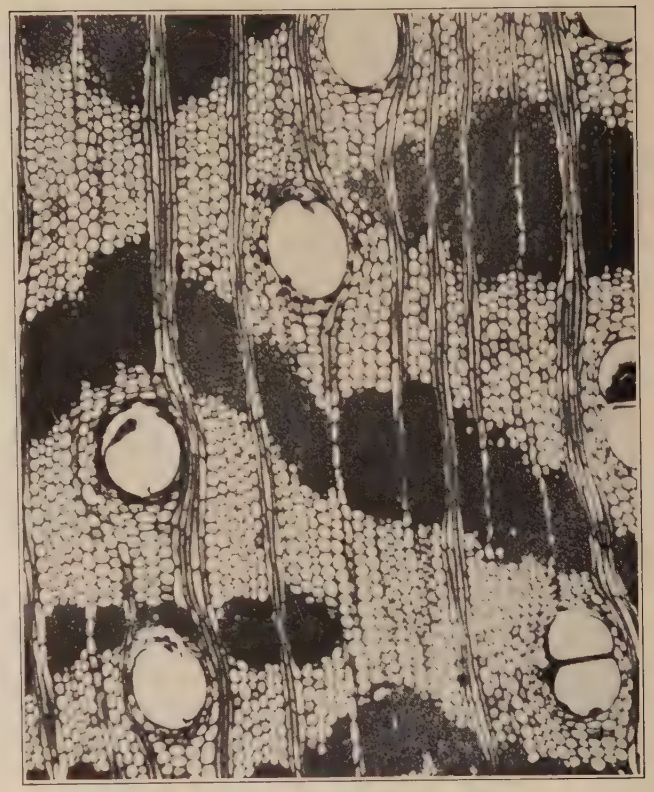
This genus consists of about 30 species of trees widely distributed in tropical America and to a much less extent in tropical Africa. The leaves are opposite, imparipinnate, the leaflets opposite and rather large; the pea-like flowers small and purplish; the pod rounded, woody, and not opening. The woods exhibit considerable range in their structure and properties, but are characterized by abundant parenchyma surrounding the vessels and showing conspicuous contrast with the fiber layers and sometimes suggesting the wood of a palm.

THE CABBAGE-BARK TREE

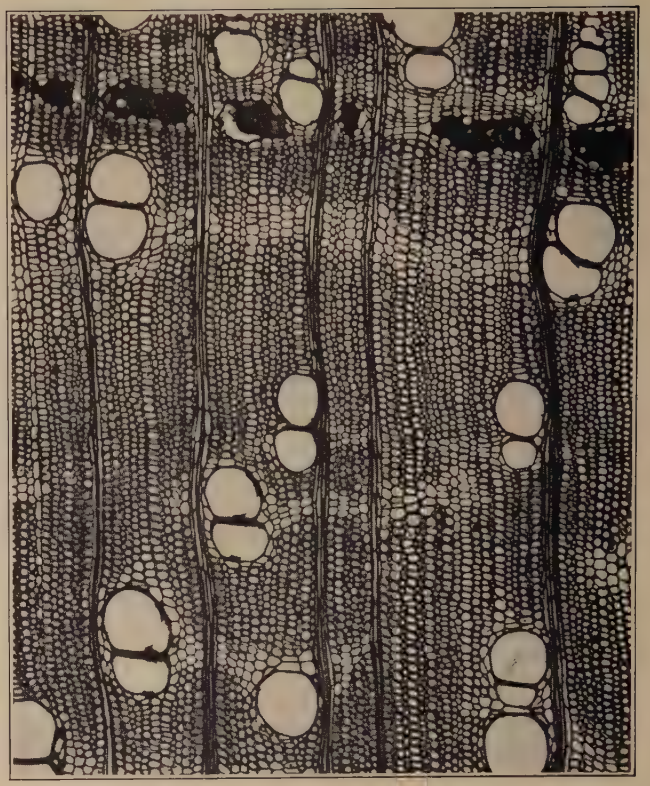
The best known species is *Andira inermis* H. B. K.,[113] with a range including the West Indies, much of South America, Central America, southern Mexico, and western Africa. The most common English name in the West Indies is cabbage-bark tree, because its ragged bark suggests the cabbage palm. The tree is usually of only medium height in the West Indies, but in parts of its range it reaches 125 feet and a diameter of five feet. The bark has a disagreeable smell and a mucilaginous taste and is used, together with the seeds, as a purgative, vermifuge, and narcotic, but in large doses it is a dangerous poison. The seeds are said to contain a poisonous alkaloid.

The wood, which has been on the market for a long time, is hard, heavy, strong, durable, and susceptible of a high polish. The color varies from yellowish to rose-colored, brown, or nearly black. The general appearance varies widely. Some of the dark-colored material looks much like palm wood, particularly on the tangential surface. The rays are very fine, uniform, and being of lighter color than the background, give rise to a fine figure on quarter-sawn material. The parenchyma is very prominent about the pores and usually in wavy bands alternating with the horn-like fiber layers. In the lighter-colored material the tangential surface of a specimen looks like hard pine. Ripple marks are present, but are sometimes irregular and not very distinct, as some of the rays may occupy more than one story. The wood has no characteristic odor and taste. Vertical gum ducts resulting from injury were observed in a specimen (Yale No. 2988) from Panama.

[113] *Andira inermis* H. B. K. = *A. jamaicensis* Urb., and is said to be the same as *A. excelsa* H. B. K.



Cross Section of Wood of Cabbage-bark Tree (x 50).
(*Andira inermis.*)



Cross Section of the Alcabu of Panama (x 50).
(*Zanthoxylum Pittieri.*)

PLATE XXX

There are many common names for this and closely related species, but there is considerable confusion in names used in the trade and some of them doubtless apply to other woods, especially to *Vouacapoua* and *Caesalpinia Ebano.*

Names reported: Cabbage-bark tree, bastard cabbage, tree cabbage, wild olive, dog almond, wormbark, angelim, partridge wood, pheasant wood (Eng.); andira, kohlbaum, wurmrindenbaum, rebhühnerholz (Germ.); angelin, arbre à chou, bois palmiste des Antilles (Fr.); legno pernice (Ital.); cuilimbuca, cuartololoti, moca, moca colorada, macallo, macayo, pacay, yaba, yabo (Mex.); yaba, yabo, yava (Cuba); moca, moca amarilla, moca blanca, moca colorada (P. R.); pois perdirx, angelica, angelin (Mart.); bois palmiste, coeur dehors, Saint-Martin rouge (Fr. G.); kabbes, roode kabbes (Sur.); kuraru, angelin, bat seed, wild olive (B. G.); morcegueira, acapú rajada, angelim, angelim preto ?, angelim vermelho ? (Braz.); angeleen, bastard cabbage-bark, angelin, lombricero (Trin.); pilon (Venez.); angelino (Col.); cocú (Pan.); almendro, a. macho, a. montes, a. real, a. del río (Salv.).

Material: Yale Nos. 830, 5016 (Cuba); 4180 (Sur.); 5400 (Fr. G.); 6628 (Hond.); 2988 (Pan.); 4243, 4294 (Braz.).

THE BITTER "ANGELIMS"

The woods of this group are characterized by a quinine-like taste that is lasting. When fresh the wood is yellow, but it turns chestnut-brown upon exposure and shows prominently the lighter-colored vessel-and-parenchyma lines. Growth rings are usually absent and the patches of parenchyma often unite the pores into diagonal rows. The woods are all coarse-textured and vary in density from rather light and soft to hard and heavy. They are divisible into two groups on the basis of the rays which are (1) low and uniform, and inconspicuous, or (2) variable in height and producing a distinct silver grain on radial surface. Ripple marks are absent or of only local occurrence. Just what species are included cannot now be determined, but wood specimens have been obtained from various parts of Brazil, British Guiana, and Central America.

Some of the trees are known to be very large and the timber is highly esteemed locally for all sorts of durable construction. The bitterness of the wood seems to guard it effectually from the attacks of termites, thus giving the wood a special value for use in the tropics. It is said also to be resistant to shipworms. One of the best known of the Brazilian timbers of this group is the "angelim amargoso," which is said to be *Andira vermifuga* Mart., although the name is to be applied also to *A. anthelminthica* Benth. and probably to other species. According to

the Rebouças,[114] *A. vermifuga* is a very large tree with a trunk 65 to 100 feet long and from six to eight feet in diameter. It is found in the State of Rio de Janeiro and neighboring regions. The bitter principle is anthelmintic and is employed medicinally. The timber is much used in civil construction but is more suited for posts and columns than for beams.

THE WOOD

Andira vermifuga Mart. (probably) *Angelim amargoso.*

Common names: Angelim amargoso, angelim dos campos, aracui, aracuhy (Braz.). Similar woods: Angelim araroba, angelim doce, angelim pedra, araroba, moina, acatrus, lombrigueira ? (Braz.); arisauru, arasaru, arrisouroo, yaksaru, yaksauru (B. G.); arisower (Sur.); guacamayo (Guat.-Hond.); amargoso (Hond.).

General properties: Color yellow, becoming yellowish-brown or somewhat reddish; with fine stripes due to parenchyma; sometimes surface shows yellow powder; lustrous. Sapwood grayish; line of demarcation not very sharp.

Odorless; taste bitter and lasting like quinine.

Of medium density and hardness. Sp. gr. (air-dry) 0.65. Weight about 40 lbs. per cu. ft. Grain roey. Texture very coarse. Wood fairly easy to cut; brittle, highly durable. Feels harsh.

Growth rings: Usually absent; when present due in part to terminal parenchyma in narrow concentric or short tangential lines and in part to more orderly concentric arrangement of pores at terminus of ring.

Parenchyma: Very abundant and conspicuous about pores and pore groups and uniting them into diagonal and wavy lines; yellowish; lighter than remainder of wood; occasionally also in fine lines, some short and some long.

Pores: Rather large, but appearing much larger on account of halo of parenchyma; occurring singly or in radial groups of two to three or occasionally more.

Vessel lines: Very conspicuous; due to parenchyma, which is lighter than background.

Vessel contents: Yellowish powder often abundant, suggesting "lapachol" of certain species of *Tecoma.*

Rays: Fine to medium; visible and sometimes very distinct on cross section; visible, but indistinct, on tangential; rather conspicuous on radial surface, appearing of lighter color than background.

Ripple marks: Absent or sometimes of local occurrence and very irregular.

Gum ducts: None observed.

Remarks: "'Angelim amargoso' yields upon extraction with benzene a beautiful compound apparently in a condition of great purity, evidently closely related to chrysarobin (chrysophan-anthranol), but of higher melting point and different minor characteristics. A trace dissolved in a drop or two of 1

[114] Rebouças, André e José: *Ensaio de indice geral das madeiras do Brazil,* Rio de Janeiro, 1877, p. 43.

per cent solution of caustic soda in the cold and exposed on a watch glass to the air, gradually darkens the solution, becoming crimson colored, probably due to the formation of chrysophanic acid or a closely allied substance." (Dr. Samuel C. Hooker.)

Specimens of "angelim amargoso" from Rio de Janeiro (Yale No. 1463) and Espirito Santo (Yale No. 3275*) are of similar structure, but are denser, not so coarse-textured, and have low inconspicuous rays as seen on radial surface. They are much like the "arisauru" of British Guiana (Yale Nos. 3032, 4208) which are commonly referred to *Vatairea* (*Pterocarpus*) *guianensis* Aubl. "Angelim pedra" of Rio de Janeiro (Yale No. 3119) is hard, heavy, coarse-textured, but with fine rays, while "araroba" (Yale Nos. 1786, 1932, 4235) is of similar structure, but has higher rays that show rather conspicuously on radial surface, and appears identical with "moina" (Yale No. 1419) of the upper Amazon. The "guacamayo" of Guatemala-Honduras (Yale Nos. 3690*, 3744) is of medium weight, very coarse-textured, and the rays are uniformly low.

Material: Yale Nos. 684, 5533 (Rio de Janeiro); 3220 (Espirito Santo). Asterisk indicates botanical material.

DIPTERYX (COUMAROUNA)

This genus consists of 11 known species having a combined range extending from Honduras through northern South America into the Amazon region of Brazil. The seeds of the "eboe" of the Mosquito Coast, *Dipteryx oleifera* Taub., is the source of an oil of good quality. The Panama species, *Dipteryx panamensis* (= *Coumarouna panamensis* Pittier), is closely related to the "eboe" and is well known in the eastern part of the republic, where it is an important element of the forests of both watersheds. It is called "almendro" because the natives roast the almond-like seeds and eat the kernels. The tree gets to be very large, often 150 feet high and over three feet in diameter. The leaves are alternate, with winged petioles and five to eight pellucid-dotted leaflets, of which the first pair is opposite, the others alternate. The pink flowers are borne in profusion in terminal panicles and make the trees conspicuous during July. The wood is little used because it is too hard.

The best known species is the "cumarú" or tonca bean, *D. odorata* Willd., one of the most beautiful trees of northern South America. It attains its best development on well-drained hillsides in the valley of the Caura River, a large tributary of the Orinoco in Venezuela, and is often 100 feet or more in height and upward of three feet in diameter. It is said to be fairly common in certain parts of British Guiana, but seems to be rare in Surinam and French Guiana. It also occurs in the Amazon region, preferring the high flood plains and the uplands.

The seeds, which are of the shape of an almond, though somewhat

larger and covered with a glossy black coat, are of considerable commercial importance in the manufacture of perfume. They owe this value to a crystalline principle called "cumarin," which has a peculiar fragrance suggesting vanilla. It is used in flavoring snuff, cigarettes, cigars, cocoa, confectionery, etc., and is becoming increasingly important. A clear yellow oil, known on the market as "cumarú," is also obtainable from the seeds and is used medicinally. The pulverized seeds form an ingredient in the preparation of sachet powders.

The wood has never been extensively used, formerly because the excessive weight of the logs made their transportation from the interior too difficult, and now because of the commercial value of the seeds. Owing to its hardness and irregular grain it is difficult to work, but will take a very high polish and presents a beautiful appearance. It has been used in this country in the form of veneer for interior trim of sleeping cars. Other uses include walking sticks, umbrella handles, fishing rods, and various articles of turnery. In British Guiana it is employed to a minor extent for cogs, millbeds, shafts, and other purposes where a strong wood capable of resisting great pressure is wanted. In the islands of the Pará estuary in Brazil the wood is used for smoking rubber; in Pará it is considered a satisfactory substitute for lignum-vitae (*Guaiacum*) in bearings.

THE WOOD

Dipteryx odorata Willd. *Tonca Bean.*

Common names: Tonca bean, tonka bean, tonga bean, tonquin bean, tonkin bean (Eng.); cuamara, kumara, gomorrow, and preceding names (B. G.); tonka, tonka boon, comarre, quamare, groot locus (Sur.); gaïac, gayac, gayac male, gayac de Cayenne, faux gayac, fevrier tonka (Fr. G.); bois de coumarouna (Mart.); gayac de Cayenne (Guad.); sarrapia (Venez., Col.); cumarú, cumarú amarello, cumarú do Amazonas (Braz.); koemarie (Hol.); cumary, camiri (Ital.); coumarounaholz, gaiacholz (Germ.). OTHER SPECIES: Coumarou-rana, tarala, Saint-Martin gris (Fr. G.); cumarú-rana, cumarirana (Braz.); almendro (Pan.); eboe (Hond.).

General properties: Color brown or yellowish-brown with a waxy appearance; somewhat streaked. Sapwood yellowish; rather sharply defined.

Odor somewhat rancid in very oily specimens; in some instances a faint vanilla scent has been noted. Taste not distinctive.

Extremely dense, hard, heavy. Sp. gr. (air-dry) 1.20; (oven-dry) 1.16. Weight (air-dry) about 75 lbs. per cu. ft. Grain interwoven and roey. Texture fine. Wood horn-like, difficult to work, rather harsh, takes a fine polish, is very strong and highly durable; has a waxy feel.

Growth rings: Present or absent; when present due to slight differences in color and to fine line of parenchyma.

Parenchyma: In narrow distinct circles about pores and in wings which

are sometimes confluent into tangential lines of varying length; occasionally, also, in very fine tangential lines independent of the pores.

Pores: Small to very small, but distinct on account of parenchyma; fairly numerous; solitary or subdivided radially; distribution often very irregular.

Vessel lines: Rather prominent due to parenchyma; often wavy.

Vessel contents: Reddish gum and white deposits common.

Rays: Very fine; invisible or at limit of vision without lens on cross section; invisible on tangential; visible on the radial as very fine and uniform ribbons of somewhat lighter color than background.

Ripple marks: Present; all elements storied; very regular; distinct without lens, showing as fine light-colored lines; about 75 per inch.

Gum ducts: None observed.

Remarks: The structure of *Dipteryx panamensis* (Yale No. 3019*; Pittier's No. 4033) is very similar to this. From available descriptions all of the woods of this genus are much alike in structure and properties. They also closely resemble "sucupira amarella" of Brazil.

Material: Yale Nos. 4074, 5117* (B. G.); 4182 (Sur.); 5396 (Fr. G.). Asterisk indicates botanical material.

PLATYCYAMUS

This genus consists of a single species, *Platycyamus Regnellii* Benth., a Brazilian tree common in the interior plateau region from São Paulo to Minas Geraes and Espirito Santo. It is commonly known as "pereira," "folha de bolo," or "angelim rosa." Though usually not over 60 feet in height, the tree has a large bole, sometimes over three feet in diameter and 30 feet in length. The leaves are composed of three heart-shaped and pointed leaflets that are sometimes a foot long; the flowers are white or purplish and borne in densely pubescent panicles; the pods are six to eight inches long, two-valved with prominent sutures, and usually contain two or three large kidney-shaped seeds.

The wood is strong and durable and is employed in general construction in both inside and outdoor work, including posts and railway ties; also to a considerable extent in the manufacture of tight cooperage. It is not considered suitable for fine furniture and cabinetwork as it is rather coarse, has no distinct figure, and the roseate color fades upon exposure. The bark is used medicinally as a febrifuge.

THE WOOD

Platycyamus Regnellii Benth. *Pereira.*

Common names: Pereira, páo pereira, pereira amarella, pereira vermelha, folha de bolo, camará de bilro, páo pente, angelim rosa (Braz.).

General properties: Color rose-red, more or less variegated, and with a

yellowish hue; fading upon exposure to a yellowish brown.

Odor and taste absent or not distinctive.

Rather hard and heavy. Sp. gr. (air-dry) 0.75. Weight about 47 lbs. per cu. ft. Grain straight or fairly so. Texture coarse. Wood rather hard to cut, finishes smoothly, is tough, strong, and durable.

Growth rings: Fairly distinct, but of variable width; due to narrow poreless zones or to fine line of terminal parenchyma.

Parenchyma: Very distinct; abundant about pores and uniting them into tangential, diagonal, or wavy lines; of lighter color than background. Some fine tangential or interrupted concentric lines mostly independent of pores also present.

Pores: Fairly large and distinct; numerous; well distributed, occurring singly or subdivided two to four times radially; joined by parenchyma into various irregular patterns.

Vessel lines: Distinct, but not conspicuous; showing plainly in proper light as result of parenchyma sheaths; mostly long and finely wavy.

Vessel contents: Some tyloses present.

Rays: Rather fine, but distinct, on cross and radial sections; appearing lighter than background; invisible on tangential.

Ripple marks: Usually present, but irregular and not always distinct; most of the rays not storied or occupy several stories; not visible without lens.

Gum ducts: None observed.

Material: Yale Nos. 3151, 3906 (São Paulo, Braz.).

ERYTHRINA

This genus consists of about 120 species of trees, shrubs, and herbacious plants with woody rootstocks, widely distributed throughout the tropics of the world and chiefly noted for their extremely light, though tough, wood. The wood of certain East Indian species finds many local uses, such as for scabbards, sieve frames, boxes, floats, and for making hats and toys.

Regarding the Mexican species, Standley[115] says:

> The species of *Erythrina* are often planted for hedges, partly because of their usually well-armed branches and partly on account of their showy red flowers. It is stated that the Aztecs used the plants extensively in this way, just as the people of modern Mexico employ them. Branches of the trees or shrubs placed in the ground root readily. The wood is very soft and light and is used for the same purposes as cork. The bark furnishes a yellow dye for cloth, etc. The succulent flowers are eaten, either raw or cooked, at Cuernavaca and elsewhere. The handsome seeds have been used by the Mexicans of both pre-Conquest and modern times as articles of ornament.

[115] Standley, Paul C.: Studies of tropical American phanerogams.—No. 3. *Cont. U. S. Nat. Herb.*, 20: 6: 176 (1919).

Various medicinal properties are attributed to the Mexican Erythrinas. The roots are said to be sudorific; a decoction of the flowers is sometimes used for chest affection; and the bark is reputed to have purgative and diuretic action. The juice of the stems is reported to have been used as a remedy for scorpion stings. The bark and seeds are said to contain a powerful alkaloid, to which the name erythrine has been given. This alkaloid has a marked effect upon the nervous system, causing paralysis of the motor nerves. If taken internally in sufficient quantities the seeds produce death. They have been used by the natives of various parts of tropical America as a hypnotic. Because of the characteristic narcotic properties the crushed stems of the plants are sometimes thrown into water to stupefy fish.

The "ceibo" of Argentina, *E. crista-galli* L., is a very common tree in that and neighboring countries. Though usually rather small, it is sometimes 100 feet high and over three feet in diameter. Because of the lightness of the logs they are often mixed in the rafts of heavy timbers to make them float. The wood is used in making wooden shoes, floats, stable floors, and for wide planks, while large canoes are dug out from the biggest trunks. The bark is a source of tanning material and the crushed flowers yield a dye.

THE WOOD

Erythrina crista-galli L. *Ceibo.*

Common names: Ceibo, ceibo macho, seibo, curtiza, zuinan, corticeira (Arg.); pisonai (Peru). Other species: Chacmaloché, chijol, chilicote, chocolín, chottza, cochizquilitl, colorín, colorín negro, coralina, coral wood, cozquelite, demthy, iquimite, jiquimite, macayxtli, madre brava, madre cacáo, patol, patol colorín, peonía, pichoco, pito, purenchequa, pureque, tzinacanquahuitl, tzompantle, tzompantli, zompancle, zompantle, zompantli, zumpantle (Mex.); ahuejote, ahuijote, pito, quilite (Salv.); pito (Guat.); elequene (Nic.); coralillo, elekene, poró (C. R.); anaco, balú, barbatuco, bucaro, cachimbo, cambulo, ceibo, chacafruto, chocho, chocho colorado, pisamo (Col.); búcare, pericoa, pericoco (Venez.); immortel, bois immortelle, búcare, madre de cacáo (Trin.); assacú, assacú-rana, suina (Braz.); coral tree, red bean tree (Jam.); bucago, búcare, palo de boyo, piñón espinoso (P. R.); búcare, búcare espinoso, piñón de costa, piñón de pito, piñón de sierra, piñón espinoso, piñón florido, piñón milagroso (Cuba); immortel du pays (Guad.); paaloe boontsji (Curaçao); wiliwili (Hawaii); dapdap (Phil. Is.); korallenholz (Germ.).

General properties: Color yellowish-white; subject to blue-stain. No distinction between heartwood and sapwood.

Without characteristic odor and taste.

Very light and soft. Sp. gr. about 0.25. Weight about 16 lbs. per cu. ft. Grain straight to irregular. Texture very coarse. Wood fibrous, tough, and strong for its weight, has a harsh feel, finishes fairly smoothly, but will not

polish, is not resistant to decay.

Growth rings: Absent.

Parenchyma: In irregular concentric bands, often wider than intervening fiber layers. In some species parenchyma makes up the mass of the wood, the fiber layers appearing as hard strands.

Pores: Large; few; scattered; solitary or subdivided; open.

Vessel lines: Few and coarse. Sometimes stained black and very conspicuous.

Vessel contents: Occasional gum deposits noted.

Rays: Coarse and distinct on all sections.

Ripple marks: Only parenchyma strands and vessel segments storied; rather irregular; not visible without lens; number per inch, 110 to 140 in different specimens.

Remarks: In some species of *Erythrina* the parenchyma cells, usually two per strand, are in secondary seriation, distinct under lens. (Yale No. 2782*, Curaçao.)

Material: Yale Nos. 2035*, 2523, 6255 (Arg.). Asterisk indicates botanical material.

26. HUMIRIACEAE

This family consists of three genera and about 30 species, with a limited distribution in Brazil and the Guianas. The genus *Sacoglottis* contains a number of species in the Amazon region where they are known as "uchi-pucú," *S. Uchi* Huber; "uchi-rana, *S. amazonica* Mart.; "uchi-curûa," *S. cuspidata* Urb.; and "uachuá" or "parurú," *S. guianensis* Aubl. There is also a tree of this genus in Trinidad, called "cojón de burro." There are several species also of *Vantanea*, one of which, *V. guianensis* Aubl., is called "uchi-rana" in Brazil and "louan-tan" in French Guiana. The woods are apparently little used and almost no information is available regarding their properties. The only genus of present importance is *Humiria*.

HUMIRIA

Of the dozen or more species of this genus the best known are *Humiria floribunda* Mart. and *H. balsamifera* Aubl., which occur generally throughout the forests of the Guianas and the Amazon region of Brazil. The various species are much alike in the general appearance of the trees and in the properties of their woods. The so-called bastard bullet tree, *H. floribunda*, of British Guiana, grows in the sandy soil near the swamps and attains a height of 90 feet and a diameter of two feet, with rather long straight clear trunks. It has an edible fruit resembling a large black currant.

The wood is used locally for building material, spokes of wheels, furniture, and often as a substitute for bullet wood (*Mimusops*) in works requiring a hard, strong, and durable material. It is said to be a practice of the Indians to remove the bark from the trunk to permit the development of a fragrantly smelling fungus which is subsequently scraped off and used for scenting hair oil. The tree yields also a small quantity of balsam resembling somewhat that of the *Copaifera* (Leguminosae). The excretion from *H. balsamifera* is collected by the Indians and thickened over fire into a kind of resin which they use for medicine.

THE WOOD

Humiria spp. *Bastard Bullet Wood.*

Common names: Bastard bullet wood, bastard bully, towanero, tauroniro, tourameira, hoorihee, hoorihea, hurihí (Br. G.); houmirí, boume houmirí, houmirí boumier, bois rouge, bois rouge tisane, bois d'encens, turi, racine, gommier de montagne, bois à flambeau, triane, omiry, homiry, umiry, umiri balsamo, couranoura, caramura, arbre à brai, toweroenierou (Fr. G.); umiri, umiry, umiry de cheiro, umiry de casca cheiro, couramira, turamira, tourameira, nieri (Braz.).

General properties: Color a dull reddish- or purplish-brown; one specimen faded yellowish on the surface from exposure to sun; sapwood reddish, not very clearly defined.

Odor and taste, absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.85 to 0.92. Weight 53 to 57 lbs. per cu. ft. Grain variable from straight to irregular. Texture medium to coarse. Wood easy to split, not easy to cut, has a rather harsh feel, is strong and durable.

Growth rings: Fairly distinct in some specimens; due to denser zones.

Parenchyma: Indistinct even with lens; scattered cells, sometimes in short tangential rows.

Pores: Rather small, but distinct; numerous, but not crowded; occurring singly or arranged in diagonal rows.

Vessel lines: Fine, long, straight; fairly distinct. The many-barred scalariform perforations can be seen with good hand lens.

Vessel contents: White substance common; also some gum deposit present.

Rays: Extremely fine; invisible on cross and tangential sections; distinct on radial surface, being somewhat darker than background. The individual cells are visible with lens on radial section, being large and mostly upright.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The available wood specimens of the different species exhibit only minor differences in structure and appearance. The fibers have bordered pits.

Material: Yale Nos. 3619, 3924, 4035 (Braz.); 3026A, 4223 (B. G.).

27. ERYTHROXYLACEAE

This family, often included in the Linaceae, embraces only two genera, namely, *Erythroxylon* and *Aneulophus*. The latter is an African genus of no commercial importance.

Erythroxylon (or *Erythroxylum*), with over 200 species of shrubs and small trees, is widely distributed throughout tropical and subtropical regions of the world. Best known is *E. Coca* Lam., a shrub growing in moist and wooded regions, chiefly on the eastern slopes of the Andes and rather extensively cultivated there and in other tropical places for its leaves, which are of commercial importance as the source of cocaine. "The leaves have the property when masticated of communicating a remarkable sustaining power, due to their containing cocaine. On this account they are chewed by the Peruvian Indian, and are to him what *betel pan* is to the Hindu, *kava* to the South Sea Islander, and tobacco to the rest of mankind. Both the alkaloid and its salts are stimulative and restorative. Injected hypodermically or painted externally, they produce local anaesthesia, and are much used in minor operations, particularly in ophthalmic and dental surgery."[116]

Little reliable information is available concerning the woods of the family. Various species of *Erythroxylon* reach tree size and the woods are said to be very hard, heavy, strong, and durable, the prevailing color of the heart being dark red. They are used locally for fuel, fence posts, telegraph poles, railway ties, and in some instances for cooperage, wheelwright work, and turnery.

The wood specimens in the Yale collections are dull red to reddish-brown, with darker layers; sapwood thin, pinkish, rather sharply defined. No characteristic odor or taste. True growth rings apparently absent, but sometimes indicated by darker or denser zones. The pores are minute, very numerous, and usually crowded, sometimes showing radial arrangement. Parenchyma is scantily developed about the pores, with a tendency to tangential arrangement, not distinct without lens. The rays are very fine, at the limit of vision on cross section, invisible on tangential, and inconspicuous on radial surface. Ripple marks and gum ducts are absent.

As to the minute anatomy: The vessels have simple perforations and very numerous minute pits. The rays are decidedly heterogeneous, one to three cells wide, the cells small and gummy; pits into the vessels vary from small, circular, and half-bordered to elliptical or much elongated and simple in the upright cells. Crystals are common in parenchyma. The wood fibers have thick walls, constricted lumina, and their pits are

[116] Watt, Sir George: *The commercial products of India*, London, 1908, p. 524.

indistinctly bordered. *Material:* Yale Nos. 2119 (Cuba); 3816 (India); 4854 (Haiti).

Common names of various species: Aroba, aroba colorada, jibá de costa (Cuba); coca, ayuelo (Col.); clavito (Venez.); arco de pipa, cataúba, catuaba, fructa de pomba, fructa de tucano, ipadú, mercurio do campo (Braz.); ajicillo, coca del monte (Arg.); coca, cuca (Peru).

28. ZYGOPHYLLACEAE[117]

The only trees in the Lignum-vitae Family belong to three closely related genera, namely, *Guaiacum*, *Porlieria*, and *Bulnesia*, which are confined to tropical and sub-tropical regions of the New World. They occur for the most part in dry situations and the trees are accordingly short and bushy, though often with stout trunks of little taper. Some of the species of each genus are typically shrubs and others tend to become so when the conditions are particularly unfavorable for their growth.

The woods have many properties in common. They are unsurpassed in density and hardness, the grain is intricately interwoven, and the heart is saturated with a mildly fragrant gum-resin which gives the woods an oily or waxy appearance and adds greatly to their usefulness. They are further characterized by extremely fine and uniform ripple marks, which are invisible without a lens and average about 250 to the inch, a considerably greater number than in the woods of any other family so far as known. The minute anatomy of *Guaiacum* is typical of the family.

PORLIERIA

The representatives of this genus are shrubs or small trees inhabiting dry sub-tropical regions, and are not of commercial importance. Four species have been described; *Porlieria angustifolia* Gray (= *Guaiacum angustifolium* Engl.) belongs to a group of plants connecting the flora of Mexico and Texas; *P. Lorentzii* Engl. and *P. hygrometrica* R. & P. (= *G. hygrometricum* Baill.) occur in the corresponding zone in Argentina and Chile; and *Guaiacum* (*Porlieria*) *microphyllum* Baill. is found in Bolivia.

Porlieria Lorentzii Engl. grows on the Argentine steppes, where it occasionally reaches a height of 25 feet and a diameter of 10 inches. The lustrous yellowish wood is very compact and fine-textured and is

[117] For a fuller discussion of the woods of this family see Record, S. J.: *Lignum-vitae: A study of the woods of the Zygophyllaceae with reference to the lignum-vitae of commerce—its sources, properties, uses, and substitutes,* Bul. No. 6, Yale School of Forestry, New Haven, Conn., 1921.

said to make a fairly satisfactory substitute for boxwood in turnery and carving. Its most common use is in the manufacture of domestic utensils, particularly spoons, thereby acquiring the vernacular name of "cucharero" (maker of spoons). The Indians use the wood, called by them "chukupi," for making smoking-pipes. Because of its combined strength and flexibility it is in demand for canes and whipstocks. It also has a minor place in carpentry. The Spanish name for this wood is "guayacan blanco."

BULNESIA

This genus, so far as known, is confined to South America. Eight species have been described, but only two supply timber of commercial value, the others being for the most part low-branching shrubs on the dry foothills of the Andes Mountains in Argentina. The flowers are yellow, the fruit is a dry capsule, and the seeds are winged, while in the other two genera the flowers are blue or purple, the fruits leathery, and the seeds have a thin, flaky, and often highly colored covering.

Bulnesia Sarmienti Lorentz occurs in groups or patches in the dry regions in Argentina, Paraguay, and Bolivia, and attains a height of 50 or 60 feet and a diameter of 40 inches, though usually it is much smaller. The wood, locally known as "palo santo," in reference to its use for incense in churches, entered the export trade about 1890 under the name of "palo balsamo." The heartwood yields upon distillation 5 or 6 per cent of oil known to the trade as oil of guaiac wood, "oleum ligni guaiaci," "guajacholzöl," or "essence de bois gaïac"; it is used in the perfume industry. The wood is used in Argentina for the same purposes as lignum-vitae, and is preferred by the Indians for fuel. The Bolivian name for the tree is "guayacan."

The "vera" of the coastal region of Colombia and Venezuela is *Bulnesia arborea* Engl. (= *Zygophyllum arboreum* Jacq. = *Guaiacum arboreum* DC.). It is a common tree of the dry foothills between Porto Cabello and Lake Maracaibo, and, as it usually grows in places more favorable for its development than is the case with the others of this family, it is often comparatively slender, straight, and of rather good timber form. Although occasionally attaining a height of 100 feet it is usually less than 50, with a clear length of 15 to 20 feet, while diameters of 14 to 20 inches are fairly common.

The wood is similar to lignum-vitae and can be used for the same purposes, though it is considered inferior for bearings because of the alleged poorer resistance to wear and greater tendency to check and split. The trade in the wood, never very extensive, is less now than formerly. The principal uses are for the steps and collars of water

turbines and to some extent for brush backs. It is also employed locally for railway ties and posts and is extremely durable.

THE WOOD

Bulnesia arborea Engl. *Vera.*

Common names: Vera, vera-wood, Maracaibo lignum-vitae, venesia (Trade); vera, vera aceituna, vera azul, vera blanca, bera, berra (Venez., Col.); guayac de Caracas (French); vera-holz (Germ.); Congo cypress (brush-back trade, local).

General properties: Color light olive-green to brown; more or less striped or banded; oily or waxy. Thin sapwood light yellow except near the heart, where the vessels may become green upon oxidation of their contents.

Mildly and pleasantly scented; noticeable when wood is warmed; distinctive. Taste slightly acrid.

Extremely hard and heavy. Sp. gr. (oven-dry) 1.11 to 1.21. Weight 69 to 76 lbs. per cu. ft. Grain interwoven. Texture fine and uniform. Difficult to work; takes a high natural polish; very durable.

Growth rings: Usually distinct because of color differences.

Parenchyma: Indistinct even with lens; in narrow circles about pores; not in lines.

Pores: Small and uniform in size; not individually distinct without lens; arranged radially in more or less branched and irregular rows.

Vessel lines: Mostly short; fine; distinct to indistinct; sometimes prominent in sapwood on account of the blue or green coloration.

Vessel contents: Most of the vessels filled with gum-resin.

Rays: Very fine, numerous, invisible without lens on cross and tangential sections; indistinctly visible on radial surface.

Ripple marks: Present; invisible without lens; regular; all elements storied, about 250 per inch.

Gum ducts: None observed.

Remarks: In *Bulnesia Sarmienti* the radial lines of pores are usually narrower and less inclined to branch. The principal distinction between the woods of *Bulnesia* and *Guaiacum* is in the arrangement of the pores.

Material: Yale Nos. 336, 342, 474, 2739, 4142 (Venez.); 2801 (Curaçao). Other species: Nos. 988, 1100, 1134, 1771, 4400 (Arg.); 4749 (Matto Grosso, Braz.).

GUAIACUM

This genus, by far the most important of the family because it supplies the lignum-vitae of commerce, is well represented on all the islands of the West Indies, the coastal regions of tropical North America, and the northern fringe of coast and adjacent islands of South America. Most of the commercial timber is supplied by Cuba, Haiti, Jamaica, the Bahamas, and the west coast of Nicaragua.

At least six species are recognized by botanists, but information

regarding the distribution of some of these is very limited. Four belong to Mexico and Central America, namely, *Guaiacum guatemalense* Planch., *G. Planchoni* A. Gray, *G. Palmeri* Vail, and *G. Coulteri* A. Gray.[118] The species producing the commercial lignum-vitae of Nicaragua has not yet been determined.

Guaiacum sanctum L. is an evergreen tree usually less than 30 feet high and 12 inches in diameter, though sometimes reaching considerably larger dimensions. It occurs throughout the West Indies, sparingly on some of the Florida Keys, and in Yucatan, probably Tabasco, and perhaps also in Vera Cruz, Mexico. The wood is of considerable commercial importance, though it is less highly esteemed, particularly in the larger sizes, than that of *G. officinale*, and is often referred to in the trade as bastard lignum-vitae.

Guaiacum officinale L. is a low or medium-sized tree with a short trunk, often 10 to 12, occasionally 18 to 30, inches through. The range includes all of the West Indies and the northern coast of South America, particularly Venezuela and Colombia. It is also credited to the natural flora of Panama and Honduras. This species is the principal source of the lignum-vitae of commerce.

Lignum-vitae enters the market in the form of bolts or logs, two to 10 feet long and from three to 20 or more inches in diameter. The sapwood is usually thin, though if the logs have lain for a long time on the ground or in the water, it may be entirely absent; such logs are often spoken of as "nigger heads." It was formerly the practice to hew off the sapwood before shipment, at least for certain grades of wood, but logs are now shipped as they come from the woods. There are decided differences in the bark characters and these serve as a ready means for distinguishing the several kinds, that of *G. officinale* suggesting sycamore (*Platanus*).

The most important as well as the most exacting use for lignum-vitae is for bearings or bushing-blocks for lining the stern tubes of propeller shafts of steamships. The great strength and tenacity of the wood, combined with the self-lubricating properties due to the resin content, make this wood especially adapted for bearings under water. Other uses are mallets, pulley sheaves, caster wheels, bowling balls, masthead trucks, stencil and chisel blocks, and turned novelties; it is used to a limited extent for brush backs.

The resin, known as "guaiac" or "guaiaci resin," which is in demand

[118] Standley (*Trees and shrubs of Mexico*, p. 523) says that *G. Palmeri* Vail is probably only a form of *G. Coulteri* A. Gray; he also considers *G. Planchoni* A. Gray a synonym for the latter species. The common names are: Guayacan, arbol santo, palo santo, mattaquahuitl, yaga-na, and yutnu-tandaa.

Lignum-vitae from Jamaica.
(*Guaiacum sanctum.*)

Lignum-vitae (Vera) from Haiti.
(*Guaiacum sanctum var.*)

Photos by S. J. Record; C. H. Pearson yards.

Lignum-vitae from Cuba.
(*Guaiacum officinale.*)

by the drug trade, is extracted with alcohol or ether from sawdust and wood waste. It is obtained also in the form of exudations, called "tears," from the living tree, or by heating sticks of the wood or by boiling chips and sawdust in water. The deep reddish-brown color of the resin changes upon oxidation to a blue or blue-green, a property sometimes made use of for differential staining.

The wood of *Guaiacum* has been an article of trade since 1508, when it was introduced to the medical profession of Europe as a specific for many of the most serious diseases of mankind. The name lignum-vitae (wood of life) originated from the supposition that the material was possessed of extraordinary remedial powers. So great was the demand that for a time the wood sold for as much as seven gold crowns a pound. Numerous learned treatises were published and served to establish the reputation of the wood so firmly that it was nearly two centuries before it was seriously questioned. Both wood and resin are now medicinally obsolete except in certain proprietary decoctions.

THE WOOD

(1) *Guaiacum officinale* L.; (2) *G. sanctum* L. *Lignum-vitae.*

Common names: (1) Lignum-vitae (U. S.; general trade); guaiacum-wood (Eng.); holy wood, wood of life, Indian wood (Lit.); guayacan, guaiacan, guajacan (Span.); lignum sanctum, guayacan blanco, hoaxacan (P. R.); guayacan negro, guayacan prieto, palo santo (Cuba); gayac jaune vert (Mart.); bois de gaïac, bois de gayac, bois sant (Fr.); pockholz, guaiacholz, guajak, guajakholz, franzosenholz, lignum sanctumholz (Germ.); guaiaco nero, legno santo, legno benedetto, legno di guaicao (Ital.); pokhout (Dutch); guaiaco (Port.); Congo cypress (brush-back trade, local).

(2) Lignum-vitae, bastard lignum-vitae (U. S.; general trade); Bahama lignum-vitae (Eu. trade); palo santo, lignum sanctum; lignum guaiaci (Span.); vera, bera (Haiti); vera amarilla, vera prieta, guayacancillo (Cuba); ironwood (Fla.); guaiaco banco, legno santo, legno benedetto (Ital.). (The woods of these species are not always distinguished and the same names are often applied indiscriminately.)

General properties: Color variable from olive-brown to dark brown or nearly black; oily or waxy. Sapwood white or yellowish, sometimes with blue or greenish vessel lines; sharply defined.

Mildly and pleasantly scented; noticeable when wood is warmed or rubbed; very distinctive. Taste somewhat acrid.

Extremely hard and heavy. Sp. gr. (oven-dry) 1.17 to 1.32. Weight 72 to 83 lbs. per cu. ft. Grain decidedly interwoven; only plane of cleavage is between growth layers. Texture fine, uniform. Difficult to work; takes a high natural polish; very durable.

Growth rings: Present or absent; sometimes distinct on account of slight

differences in depth of color; in some specimens rings are demarcated by fine parenchyma lines and sometimes also by variation in size of pores.

Parenchyma: Not distinct without lens; in narrow circles about pores and sometimes connecting them tangentially; also in tangential lines of variable length and sometimes in concentric lines apparently limiting seasonal growths.

Pores: Small, though often variable in size; distinct to indistinct; irregularly distributed, sometimes abundant, sometimes few and scattering; usually without definite arrangement, but occasionally in diagonal rows and rarely showing tendency to ring-porous formation.

Vessel lines: Usually short and indistinct in heartwood; may be very distinct in inner sapwood due to blue or green coloration.

Vessel contents: Much gum-resin present, filling most of the vessels.

Rays: Very fine, numerous, invisible without lens on cross and tangential sections; indistinctly visible on radial surface.

Ripple marks: Present; invisible without lens; regular; all elements storied, about 250 per inch.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; intervascular pits very small and crowded. Rays heterogeneous; mostly uniseriate and one to eight (mostly five or six) cells high; cells small, thick-walled, sometimes with crystals, commonly resinous; pits into vessels small, numerous, half-bordered. Parenchyma fairly abundant; cells small, resinous. Wood fibers very thick-walled, narrow and short; pits weakly bordered. All elements in horizontal seriation.

Remarks: The woods of the different species of *Guaiacum* apparently exhibit no greater variation than can be noted within the same species.

Material: Yale Nos. 780, 4139, 4140 (Cuba); 4139, 4800*, 4808*, 5931* (Haiti); 5065, 5066 (S. D.); 2143*, 2150* (Curaçao); 4141*, 5209* (Florida); 4137 (Nic.); 2944*, 4739 (Mex.). Asterisk indicates botanical material.

29. RUTACEAE

The Satinwood Family consists of about 110 genera and over a thousand species of trees, shrubs, and a few herbaceous plants, widely distributed throughout the warm and temperate regions of the earth and most abundant in South Africa and Australia. The best known genus is *Citrus*, cultivated so extensively in tropical and sub-tropical regions for its fruits, the orange, lemon, lime, grapefruit, citron, etc.

The woods of this family, of which the satinwood and orangewood are the best known, vary in density from rather light and soft to extremely hard, heavy, and fine-textured resembling boxwood. The color is usually light, but varies from white to different shades of yellow and brown. Some of them are oily or resinous and a few are scented. Growth rings are usually distinct, due to bands of terminal parenchyma, differences in

density, or to abundance of pores. In most instances parenchyma is scantily developed except for the concentric lines of uneven spacing, usually running together at intervals when closely spaced, but sometimes it is fairly abundant and may extend wing-like from the pores and unite them tangentially, as in *Citrus* and *Evodia*. The pores are small to minute, typically in radial groups of two to several or in rather long radial rows. The rays are fine and inconspicuous. Ripple marks have been observed only in the East Indian or Ceylon satinwood (*Chloroxylon*) and the Brazilian satinwood (undetermined). Vertical gum ducts due to injury are of very common occurrence, being arranged in single tangential rows in association with parenchyma, and often showing as fine dark lines on longitudinal surface; they have been observed in *Balfourodendron, Chloroxylon, Citrus, Esenbeckia, Euxylophora, Helietta, Pilocarpus,* and *Zanthoxylum.* (Plate XXX.)

ZANTHOXYLUM (FAGARA)

Zanthoxylum (*Xanthoxylum*) and *Fagara,* considered distinct genera by Engler,[119] are more commonly treated as synonyms. In this broader sense the genus *Zanthoxylum* includes over 200 species of trees and shrubs widely distributed through tropical and extratropical regions, but most abundant in tropical America. The trees are mostly small or of medium size, only occasionally exceeding 50 feet in height with trunk diameters of 12 to 18 inches, rarely two feet. In many cases the limbs are armed with spines or prickles, and portions of the stems may be covered with corky knobs. The resin of the bark, especially of the roots, is sometimes used medicinally as a stimulant and tonic.

The woods exhibit considerable variation in their physical properties, though in general they are hard and heavy to moderately so, fairly easy to work, and often of good cabinet qualities. The color is yellow, in various shades from very light to brownish, sometimes canary or more or less greenish. The last is characteristic of the two available specimens (Yale Nos. 896, 901) of the "cochucho" or "coco" of Argentina, *Z. Coco* Gill., and is much the same, even to the brown streaks, as that of the Australian *Z. brachyacanthum* F. Muell.

WEST INDIAN SATINWOOD

There are at least two, possibly several, species of *Zanthoxylum* which contribute to the supply of West Indian satinwood of commerce, though the best is the product of *Z. flavum* Vahl. This is an unarmed tree rarely 40 feet high and 20 inches in diameter, usually very much smaller and

[119] *Pflanzenfamilien,* 3: 4: 115.

sometimes reduced to a shrub, with a range including Santo Domingo, Porto Rico, the Bahamas, Bermuda, and southern Florida. The wood is hard, heavy, and fine-textured, often with a beautiful, wavy grain, and of a creamy or golden-yellow color, with an oily appearance and feel, giving off a pronounced scent of coconut when freshly worked. Its principal uses are for fine furniture and cabinetwork, inlay and marquetry, brush backs, and turnery.

Mr. Karl Schmieg, of Schmieg & Company, cabinet makers in New York City, writes as follows: "We use three different kinds of satinwood. The first and best quality, from the standpoint of texture and figure, comes from Porto Rico, the next from Santo Domingo; both being known under the name of West Indian satinwood. Most of the antique satinwood furniture is almost exclusively of this wood, since, as in the case of mahogany, it was the most readily accessible for shipping. The East Indian satinwood, imported from Ceylon and British India, is generally more highly figured, paler in color, and somewhat harder than the West Indian satinwood, and is frequently confused with prima vera mahogany on account of its similarity in color and figure when polished."

Another kind of West Indian satinwood is known to the trade as "concha" satinwood. It differs from the other in being coarser-textured, less heavy and firm, and is a slightly dull brown rather than a lustrous golden-yellow, and is without pronounced scent. Dealers consider it an inferior grade of wood, but some of it is beautifully figured and gives a very pleasing effect when made into furniture. New York cabinet makers are using it to some extent and state that it has proven very acceptable to such of their trade as prefer the brown or grayish tone to the more pronounced yellow of the true satinwood.

There appears to be a difference of opinion in England as to the merits of this wood. That it has not met with favor in England is evidenced by the following letter of Messrs. Richard Forshaw & Company, Ltd., of Liverpool: "Some years ago we imported a quantity of round satinwood from Santo Domingo and as the wood on arrival had all the appearance in colour and growth of that which we were in the habit of receiving as round satinwood, we dispatched it to several of our customers. A short while after this we began to receive complaints together with specimens of some of the logs we had delivered. These pieces were totally different from true satinwood, being of a spongy texture and of no merit. Nearly half of the lot turned out to be of this character and both our customers and ourselves had been quite deceived, as the bark and the ends of the logs presented all the appearances of genuine satinwood. We reported this matter to our shipper in Santo Domingo and in

due course had a reply from him to the effect that he had included in this consignment a number of logs of 'concha satinwood.' "

Howard[120] says: "This timber, known in London as 'harewood,' and in Liverpool as 'concha satinwood,' is imported in square-hewn logs, from about eight to 24 inches square and eight to 20 or more feet long. In San Domingo it is called 'pino macho' (male pine), and so distinguished from satinwood, which is known as 'espanello.' At first sight these two woods appear to be very similar in colour, weight, and texture. Harewood, however, though yellow in colour and displaying a beautiful satiny lustre, is more dull and greyer or browner in tint, and is sometimes traversed by black 'gum' streaks; moreover, on exposure to light and air its greyness gradually increases until with age the wood acquires a silver-grey hue characteristic of genuine old harewood and has been imitated by staining sycamore to produce artificial harewood.[121] The majority of logs imported show abundant roe and mottle figure, with a preponderance of fiddle mottle effect. Some of these have realised very high prices for veneers (£3 or more per cubic foot). When used for panelling and banding in cabinetwork the wood produces attractive and artistic effects. It might with advantage be used for the backs of brushes of the highest quality."

A specimen of this wood furnished the author by Mr. Howard agrees fairly closely with material obtained on the New York market under the name of "concha" satinwood. It unquestionably belongs to *Zanthoxylum*, but the exact species producing it is yet to be determined. It is not unlikely that there are several kinds of the so-called "concha" satinwood on the market and that the name is applied indiscriminately to any woods of the genus which the trade does not recognize as genuine satinwood, since there are a number of species in the West Indies that yield woods of this general type.

In this group may be mentioned *Z. elephantiasis* McFad., a tree 15 to 50 feet high and sometimes 18 inches in diameter, growing in Cuba, Santo Domingo, Jamaica, and sparingly throughout Central America from southern Mexico to Darien, Panama. In Jamaica it is known as yellow sanders. Another is *Z. martinicensis* Lam., one of the largest trees of the genus, sometimes 75 feet high and over two feet in diameter with a reddish-yellow, somewhat streaked wood useful for furniture, cabinetwork, and building construction. It is known as "cenizo" or

120 Howard, Alexander L.: *A manual of the timbers of the world,* London, 1920, p. 95.

121 Authorities on period furniture whom the authors have consulted are unanimous in their statement that harewood is stained maple, or sycamore as it is called in Europe.

"espino" in Porto Rico, prickly ash in the British West Indies, and "ayúa amarilla" or "ayuda" in Cuba. The "bayúa" or "bayuda" of Cuba, *Z. coriaceum* A. Rich., is also common on other islands of the West Indies and reaches southern Florida. Its brownish-yellow wood is of good quality and often beautifully mottled. *Z. rhodoxylon* P. Wilson is a Jamaican tree 25 to 50 feet high and up to two feet in diameter, without prickles; it is known locally as rosewood or Caesar-wood.

The structure of the various species shows considerable uniformity, the principal differences in the woods being in their density, texture, color, and odor. Growth rings are usually distinct, parenchyma is mostly limited to fine lines terminating the rings, the pores are in radial groups of two or three, ripple marks are absent, and vertical gum ducts are fairly common. The genuine West Indian satinwood is described in detail because of its importance, but some of the other species, less well known, are more nearly typical of the genus.

THE WOOD

Zanthoxylum flavum Vahl — *West Indian Satinwood.*

Common names: West Indian satinwood (Trade); satinwood, yellow wood (B. W. I., gen.); Jamaica satinwood, yellow sanders (Jam.); espinillo (S. D.); satiné jaune (Fr. W. I.). Other species: Prickly ash, sea ash, wild lime, wild orange, toothache tree, pepperwood, wait-a-bit, tear-blanket, frêne-piquant (U. S.); wild lime, satinwood, Cuban yellow wood, Hercules' club, doctor's club (Bah.); yellow sanders, yellow Hercules, prickly yellow, saven tree, bastard ironwood, rosewood, Caesar-wood, lignum rorum, licca tree, suarra wood (Jam.); cenizo, espino, espino rubial, carubio, mapurito, rubia (P. R.); ayúa, ayúa amarilla, ayúa blanca, ayuda, ayuda blanca, ayuda hembra, ayuda macha, ayuda varia, bayúa, bayúa lisa, bayuda, espino, limón café, limoncello, mate arbol, tomeguin, zorillo (Cuba); bois jaune, bois épineaux jaune, bois piquant, bois manche-houe, espin de bobo, espineux blanc, espineux jaune, mapurito, pini jaune, noyer, noyer des Antilles (Fr. W. I.); geel steckel boom, prietjarie (?) (Sur.); cacatier (Galibis); l'epineux, mapourita, espina de bobo, noyer, nogal, prickly yellow, yellow sanders (Trin.); bosua (Venez.); calabori (Curaçao); uña de gato (Col.); ruda, alcabu (Pan.); lagartillo (C. R.); colima, limoncillo, palo de ropa, palo mulato, uñagato, uña de gato, xic-ché, zorillo (Mex.); cedro espino, salitrero (Salv.); espinho do vintem, laranjeira do matto, mammica de cadella, tembetarú, tamanqueira (Braz.); coco, coco de cordoba, cochucho, cuentrillo, curatú-rá, mamica de cadella, naranjillo, sacha limón, sauce hediondo, tembetary (Arg.).

General properties: Color lustrous yellow, deepening upon exposure; somewhat oily appearance. Sapwood yellowish-white; not very distinct.

With scent of coconut oil; very distinct when wood is worked. Taste rather unpleasant.

Hard and heavy. Sp. gr. (air-dry) 0.90. Weight about 56 lbs. per cu. ft. Grain irregular, roey, wavy or variously mottled. Texture fine, uniform. Wood fairly easy to cut, takes a beautiful polish, holds its shape fairly well, appears fairly durable. Veneers of very oily material may cause trouble in gluing.

Growth rings: Distinct; due to parenchyma lines and sometimes also to slight differences in porosity; usually visible on all sections.

Parenchyma: In narrow, but distinct, concentric lines of uneven spacing, but usually wide enough apart to appear to limit seasonal growths; not visible about pores.

Pores: Small, not distinct without lens; fairly numerous; well distributed; occurring singly or more often in radial groups of two to three, open.

Vessel lines: Fine and indistinct. In other species often darker than background and showing distinctly as hair-like lines.

Vessel contents: Some gum deposits noted. Very distinct in certain other species.

Rays: Fine, but distinct, on cross section; faintly visible on tangential; distinct, but not conspicuous, on radial surface, producing a fine silver grain in proper light.

Ripple marks: Absent.

Gum ducts: None observed, but probably occur. Noted in other species.

Minute anatomy: Vessels with simple perforations; bordered pits rather small, numerous. Rays mostly homogeneous; pits into vessels half-bordered, those in parenchyma wall often lattice-like and covering several in vessel wall. Fibers with simple or indistinctly bordered pits.

Remarks: The West Indian satinwood is readily distinguished from the East Indian or Ceylon satinwood because of the fact that the latter has distinct ripple marks and the pores are in rather long radial rows.

Material: Yale Nos. 725, 796, 2734, 4067, 4933, 4934, 4935 (West Indies). Other species: Nos. 785, 896, 901, 2444, 3025, 4193.

ESENBECKIA

There are about 25 species of *Esenbeckia* in tropical America. The "atata" of Venezuela, *E. Atata* Pittier, is a small tree in the dry thorn forest of the coastal region. The wood is hard, heavy, very fine-textured, of a light yellow color and rather oily. It was formerly exported to Germany and occasionally reaches the New York market as a substitute for boxwood. In the only specimen available (Yale No. 443) the growth rings are narrow and distinct, due to fine white parenchyma lines; the pores are indistinct without lens and arranged in short radial rows; the rays are extremely fine, scarcely visible with lens on cross section, and very inconspicuous on radial surface. Ripple marks are absent. Very small vertical gum ducts are sometimes present. The wood is somewhat cross-grained, cuts smoothly, and takes a very high polish. If it can be had in proper sizes free of defects it should prove valuable as a

substitute for some of the uses of boxwood, though there is too much parenchyma to permit its use for engraving.

There are several species of *Esenbeckia* in Brazil, but the wood specimens available (Yale Nos. 3154, 3163) are of doubtful authenticity and resemble *Citrus* in having wood parenchyma in terminal lines and also in long, often confluent wings from the pores, which have little or no tendency to radial grouping. *E. febrifuga* Mart. is said to resemble the orange tree in general appearance, producing a wood with a specific gravity about 1.08, fine-textured, suitable for carving and used in turnery and for the manufacture of wooden spoons and vessels. The bark is used as a substitute for quinine. The common names are: Larangeira do matto, quina do matto, mamonhinho, tres folhas vermelhas.

E. leiocarpa Engl. is a small or medium-sized tree, rarely 18 inches in diameter, growing in the same region, namely, Rio de Janeiro, São Paulo, and Minas Geraes. The lustrous golden-yellow wood is said to be hard and heavy, specific gravity 0.97 to 1.10, hard to cut, durable and used for sills, fence posts, bridges, and other uses in exposed situations. The common names are: Guarantá, guarantán, páo duro.

E. grandiflora Mart. is another small or medium-sized tree of the same general region and is said to produce a wood of great strength and toughness, used for canes, bows, shafts of vehicles, spokes of wheels, and similar purposes. The common names are: Páo de cotia, canella de cotia.

BRAZILIAN SATINWOOD

Specimens of Brazilian satinwood supplied by J. H. Monteath Company, of New York City, have a structure which agrees very closely with that of the East Indian satinwood, *Chloroxylon Swietenia* DC., and with a specimen of "guarantán" (Yale No. 3907A) from J. Monteiro & Company of Sáo Paulo, Brazil. "Guarantán" is commonly referred to the genus *Esenbeckia*, but these woods are very different from the presumably authentic specimens of this genus. The wood is not as lustrous or as dense as that of *Chloroxylon*, but in all other respects the similarity is very marked. No other woods of the Rutaceae are known to have ripple marks.

THE WOOD

? *Esenbeckia* sp. *Brazilian Satinwood.*

Common names: Brazilian satinwood (Trade); guarantán ? (Braz.).

General properties: Color yellow to brownish-yellow, sometimes with slight pinkish or purplish variegations; somewhat oily; fairly lustrous. Sapwood lighter, not very clearly distinguished.

Hard, heavy, compact. Sp. gr. (air-dry) 0.89. Weight about 56 lbs. per cu.

ft. Grain straight to decidedly irregular. Texture fine. Wood easy to work; takes high polish, brittle, looks durable.

Growth rings: Very distinct, due to terminal parenchyma and somewhat more numerous pores in inner portion of ring.

Parenchyma: In fine lines terminating growth rings; distinct on cross section; fairly visible on longitudinal; of lighter color than fibers.

Pores: Very small, not individually distinct without lens; arranged in radial rows distinct without lens; numerous, more so in early wood; open.

Vessel lines: Fine and inconspicuous; annular ridges of vessel segments distinct.

Vessel contents: Some white deposits noted and gum present.

Rays: Very fine; visible on cross section, but not on tangential; distinct on radial surface in proper light, being of nearly the same color as background.

Ripple marks: Present; visible without lens; fairly regular; number per inch 80 to 85; all elements storied; some of the rays occupy more than one story.

Gum ducts: Vertical ducts in tangential rows common; small; filled with dark reddish substance showing as fine streaks on radial surface.

Minute anatomy: Vessel perforations simple; usually plugged with gum; annular ridge prominent; pits small, round, with lenticular mouths. Rays three or four cells wide, 15 to 25 cells high (in specimen No. 3907A some of rays are very much higher); mostly homogeneous, but sometimes marginal cells are square; all thick-walled; pits into vessels half-bordered and of same size and shape of other vessel pits. Fibers have thick walls and simple pits. Agrees in all essentials with *Chloroxylon* except as to the height of the rays in No. 3907A.

Material: Yale No. 3907A (São Paulo); 4926 (Rio de Janeiro).

EUXYLOPHORA

This genus was established by the late Dr. Huber who says:[122] "The most important representative of this family (Rutaceae) in Pará, from the point of view of the utilization of its wood, is the 'páo amarello,' a large tree of the forests of the uplands of the eastern and southern part of the state. Not until a few years ago did I succeed in obtaining flowers and fruits of this tree, being supplied by the Experiment Station Augusto Montenegro, where it is fairly common, though not abundant. Examination of this material revealed the unexpected fact that the 'páo amarello' is a representative of a new genus of the tribe Cusparieae, to which I gave the name *Euxylophora* in token of the excellent wood which it produces. . . . The 'páo amarello' is one of the most useful woods of Pará and, if found in greater abundance (I hear that in certain places, as for example in the upper Capim and in certain stretches of the Tocantins, it is very common), it would have more varied applica-

[122] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 184-185 (1909).

tions. On account of the large size of its trunks and the great homogeneity of its beautiful light-yellow wood, it can be used for doors, tables, etc., which require wide planks. It has its most frequent application in the beautiful floors made of alternate boards of 'acapú' and 'páo amarello' which add so much to the attractiveness of the houses of Pará. And also in furniture the juxtaposition of 'páo amarello,' especially the pieces with curly grain which are sometimes called 'páo setim,' to dark-colored woods such as 'acapú,' 'páo santo,' 'jacarandá,' 'macacaúba,' etc., produces a most beautiful effect. It is probable that the wood, were it possible to cultivate it (which unfortunately does not appear to me to be an easy thing, judging from our experiences), could be exported on a large scale and meet with an unlimited market. As conditions now exist, the 'páo amarello' is a rather costly wood even here and probably could not be exported with profit."

Small lots of logs of this wood have entered the New York market from time to time, but have not met with very ready sale because the material lacks figure and other special properties essential for cabinet-work and fancy articles, but is rather in the class with maple (*Acer*).

THE WOOD

Euxylophora paraënsis Huber — *Páo Amarello.*

Common names: Páo amarello, páo setim, amarello (Braz.); sateen wood (Trade).

General properties: Color uniform bright clear yellow, deepening upon exposure; fairly lustrous. Sapwood nearly white; not very clearly defined.

Odor and taste absent or not distinctive.

Rather heavy and hard. Sp. gr. (air-dry) 0.81. Weight about 51 lbs. per cu. ft. Grain mostly straight; sometimes wavy or roey. Texture medium, uniform. Wood strong, difficult to work, takes a smooth finish, appears fairly durable.

Growth rings: Absent or indistinct; sometimes present due to variations in abundance of pores, but not sharply defined, and less distinct with lens than without it.

Parenchyma: Indistinct or invisible even with lens; not in lines.

Pores: Rather small, but visible; fairly numerous, open, thin-walled; well distributed; arranged in short radial rows of two to eight, mostly two to four; open.

Vessel lines: Distinct as fine, mostly long, scratches; not conspicuous.

Vessel deposits: None observed.

Rays: Fine, but distinct, on cross section; invisible on tangential; distinct, but not conspicuous, on radial, where they are of the same color as or lighter than background.

Ripple marks: Absent.

Gum ducts: A few vertical ducts noted in one specimen (Yale No. 3929) in patch of parenchyma resembling a large pith fleck and evidently of traumatic origin.

Minute anatomy: Vessels with simple perforations; pits abundant, very small, mouths often extending beyond borders. Rays homogeneous, coarse-celled, two or three cells wide and few to 40 cells high; pits into vessels half-bordered, those in parenchyma wall often extending over two or three in vessel. Wood fibers with simple pits.

Material: Yale Nos. 2080, 3910, 3929, 4027, 4033, 4927 (Braz.).

HELIETTA

Helietta, with six known species having fruits resembling small clusters of maple seeds, is distributed from the valley of the Rio Grande in Texas to Brazil and Argentina. *H. parviflora* Benth. often forms thickets of considerable extent in Texas, but is of larger size on the lower slopes of the Sierra Madre Mountains and in Nuevo Leon in Mexico. The wood, which is of a light orange-brown color and very hard and heavy, is used to some extent in Mexico for building purposes. The common name is "barreta."

H. cuspidata (Engl.) Chod. & Hassl. of Misiones, Argentina, is a tree 50 to 65 feet high and sometimes two feet in diameter, supplying timber for tool handles, vehicle construction, cabinetwork, and various articles of turnery such as billiard cues and walking sticks. It appears suitable for shuttles. The lustrous white or pale yellow wood is fine-textured, hard and heavy, and takes a beautiful polish. Growth rings are distinct, due to white lines of parenchyma and sometimes also to a narrow poreless zone in the inner portion. The pores are very small and appear as white dots; numerous; mostly in twos; often with noticeable tendency to arrangement in concentric bands which may produce an elm-like pattern on tangential surface. Rays not visible without lens on cross and tangential sections, fine, but fairly distinct, on radial. Ripple marks absent. Small vertical gum ducts occasionally present in wider bands of parenchyma. The common names are: Iberá-obi, iberraobi, canella do venado, canella do viado. *Material:* Yale Nos. 1716, 3981 (Arg.).

BALFOURODENDRON

There is only one known species of this genus, namely *Balfourodendron Riedelianum* Engl. (= *B. eburneum* Mello), a small to medium-sized tree in São Paulo, Brazil, where it is usually called "páo marfim," and Misiones, Argentina, where it is known as "guatambú blanco." In the latter region it reaches a height of 50 to 65 feet and a diameter of 30 inches. The fruit is a four-winged capsule over an inch in diameter.

The wood is of excellent quality and highly esteemed for general construction, turnery, cabinetwork, tool handles, oars, and agricultural implements. It has somewhat the same properties and uses as sugar maple (*Acer saccharum* Marsh.). (Plate XXXII.)

THE WOOD

Balfourodendron Riedelianum Engl. *Páo marfim.*

Common names: Páo marfim, pequia marfim, marfim, páo liso (Braz.); guatambú, guatambú blanco, guatambú moroti (Arg.); ivory wood.

General properties: Color nearly white to yellow; sometimes with fine dark streaks; rather dull. Sapwood white; not very clearly distinguished.

Odor and taste absent or not distinctive.

Hard and heavy and compact. Sp. gr. (air-dry) 0.75. Weight about 47 lbs. per cu. ft. Grain mostly straight, sometimes with peculiar wavy streaks. Texture fine. Wood strong to medium, rather easy to work, finishes smoothly, takes glue well, does not appear durable.

Growth rings: Distinct or fairly so; due to concentric lines of parenchyma, which may exhibit considerable variation in width and spacing.

Parenchyma: In small amount about pores and often uniting them irregularly; fairly distinct, but not conspicuous; may produce fine, indistinct pattern on tangential surface; also in concentric lines, mostly fine, but of variable width at limit of growth rings; visible on longitudinal section. Pith flecks sometimes present.

Pores: Rather small; visible only because of parenchyma about them; very numerous; single or in radial groups of two or three, often joined by parenchyma into irregular wavy tangential lines.

Vessel lines: Fine and inconspicuous; visible in proper light owing to lower luster of the parenchyma.

Vessel contents: Vessels open; some gum deposits noted near wounds.

Rays: Very fine; visible on cross section, but not tangential, with lens; distinct, but fine and inconspicuous, on radial, being of the same color as the background.

Ripple marks: Absent.

Gum ducts: Small vertical ducts common in tangential rows in association with parenchyma; filled with yellowish or brownish substance; fairly distinct on longitudinal surface as fine brownish streaks.

Minute anatomy: Vessels with simple perforations; pits small, very numerous; mouths of two or three often coalesce laterally. Rays homogeneous, fine-celled, three or four cells wide and few to 50 cells high; pits into vessels half-bordered, resembling other vessel pits. Wood fibers with simple pits.

Remarks: The wood has a structure similar to that of *Helietta cuspidata*, but is coarser-textured and of much duller appearance.

Material: Yale Nos. 1692 (with fruit), 1694 (with leaves and fruit), 4132 (Arg.); 1793, 3167, 3902, 4886, 4923 (Braz.).

AMYRIS

This genus consists of about 30 species, a few of which supply wood of commercial value for its resin and oil content.

The torchwood, *Amyris elemifera* L., occurs in Florida, the West Indies, northern South America, and Central America. It varies in size from a shrub to a tree 50 feet high and 12 inches in diameter. The wood is little used except for fuel and torches.

The most important species is *A. balsamifera* L., a tree 20 to 40 feet high and sometimes over two feet in diameter, common in the West Indies and extending through northern South America to Ecuador. Its commercial exploitation is largely centered in Venezuela where it grows in the dry regions along the coast and is usually known as "quigua." It is also called "amyris legitimo" to distinguish it from the "candil de playa," *A. simplicifolia* Karst., and the "candil de montaña," *A. sylvatica* Jacq. Before the war the wood was exported in large quantities to Germany and later in smaller amounts to New York for the production of an essential oil known as amyris oil or West Indian sandalwood oil. It was at first imported into the United States under the name of sandalwood, but in order to comply with the provisions of the Food and Drug Act the name was changed to amyris wood.

THE WOOD

Amyris balsamifera L. *Amyris Wood.*

Common names: Amyris wood, West Indian sandalwood, Venezuelan sandalwood (Trade); quigua, tigua, amyris legitimo, sándalo de las Antilles (Venez.); tea (P. R.); rosewood, torchwood (Jam.); cuaba blanca, palo de roble (Cuba). Other species: Torchwood, white torch, candle wood (B. W. I.); tea, palo de tea (P. R.); cuaba amarilla, cuaba amarilla de costa, cuaba blanca, cuaba de costa, cuaba del monte, cuaba de sabana, cuabilla, incienso, incienso de costa, palo de incienso, palo de resina (Cuba); bois handelle (Guad.); candil, candil de montaña, candil de playa (Venez.); ulanda, marfil, palo de marfil, naranjito (Col.).

General properties: Nearly colorless, becoming yellowish or brownish upon exposure; more or less oily, sometimes decidedly so. Sapwood thin, white, distinct, and sharply defined in old specimens.

With fragrant or sometimes rather unpleasant odor. Taste spicy-resinous.

Very hard and heavy. Sp. gr. (air-dry) 0.99 to 1.10. Weight 62 to 68 lbs. per cu. ft. Grain fairly straight. Texture very fine and uniform. Wood brittle, easy to work, takes a lustrous polish, very oily specimens appear highly durable.

Growth rings: Fairly distinct; due to fine parenchyma line and sometimes also to slight differences in porosity.

Parenchyma: In fine concentric lines apparently limiting growth rings; also few cells about vessels.

Pores: Minute; not distinct without lens; numerous; fairly well distributed; arranged in radial rows.

Vessel lines: Very fine and indistinct.

Vessel contents: Gum deposits common.

Rays: Very fine; not visible without lens on cross and tangential sections; visible, but low and inconspicuous, on the radial.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; densely pitted with small bordered pits; striate. Rays mostly uniseriate and only a few cells high; pits into vessels half-bordered, resembling other vessel pits. Fibers thick-walled with simple pits.

Remarks: The woods of various species are very much alike in structure.

Material: Yale Nos. 4086 (Venez.); 2133 (Curaçao); 743, 793 (Cuba).

CITRUS

The wood of the various species of *Citrus* enters the market in limited quantity in the form of small and generally irregular logs or sticks under the name of orange wood. It is used for making manicure sets, small articles of turnery and carving, fancy boxes and novelties. The wood is of a light yellow color, has no distinctive odor or taste, is hard, heavy, strong, and fine-textured, takes a high polish, and is fairly easy to work. Parenchyma is about the pores and in more or less confluent wings, and also in concentric bands which sometimes appear to limit seasonal growths or may be crowded and run together at intervals. The pores are small, visible as white dots, fairly numerous, well distributed, occurring singly or in short radial groups. The rays are very fine, not visible without lens except on radial section. Ripple marks are absent. Vertical gum ducts are of frequent occurrence. *Material:* Yale Nos. 2719, 4089, 4574, 4665.

30. SIMARUBACEAE

The Bitterwood Family, consisting of about 28 genera and some 150 species of trees and shrubs, is confined chiefly to the tropics and to the warmer parts of the northern hemisphere. The best known representative is the so-called tree of Heaven, *Ailanthus*, a native of northern China, which has been widely planted for shade and ornamental purposes and in many places has become sparingly naturalized. This genus contains some of the largest trees of the family and the light and soft wood is distinguished from the others by the fact that it is typically ring-porous. There are several arborescent genera in tropical America,

but the species are mostly small trees or shrubs, noted for the bitter principle of their bark and wood.

QUASSIA

Of the five species of this genus, two in tropical America and three in Africa, the best known is *Quassia amara* L., which supplies the South American bitterwood or quassia of commerce. Its principal region of growth is northern South America, but its range has been extended widely through cultivation in the tropics of both hemispheres. It is a small tree rarely over 25 feet high and from six to 12 inches in diameter, with a grayish-white bark, large crimson flowers, and pinnate leaves with winged petioles. The wood enters the market, mostly from Surinam, in the form of billets about four feet long and free of bark, the latter being sold as a separate commodity. All parts of the tree contain an intensely bitter principle, "quasin," of tonic properties, and formerly considered of considerable value as a febrifuge. The bitter principle is readily soluble in cold water, and drinking cups made of the wood impart a bitter taste to the water. The manufacture of these cups gave rise to a small industry in this country some years ago, but there is no longer any demand for them. The principal use of the wood now is for the manufacture of insecticides, particularly for spraying hops; also as a substitute for hops in ale and beer, and as an ingredient in certain proprietary medicines and in "conditioning powders" for domestic animals.

The wood (Yale No. 2459) is white or slightly yellowish, odorless, but with extremely bitter and persistent taste. It is light and soft (sp. gr. about 0.50), easy to cut, and resistant to insects, but not to decay. Parenchyma is associated with the pores, extending wing-like and often connecting them tangentially; also in concentric lines at irregular intervals, sometimes appearing to limit growth rings. The pores are small but visible, numerous, but not crowded, occurring singly or in small groups. The rays are barely visible on cross section, invisible on the tangential, inconspicuous on radial surfaces. Ripple marks are absent. No gum ducts were observed.

Common names: Quassia, Surinam quassia, bitterwood, South America bitterwood (Trade); quassia, lignum quassiae, lignum quassiae Surinamensis (Pharm.); kwassi, kwassie bitterhout (Sur.); quina de Cayenne, quinquina de Cayenne, bois de frêne, bois de quassie, bois amer, bois de Surinam, quassia verum, coachi (Fr. W. I.); cuasia (Col.); guabo (C. R.); cuasia, tinco (Mex.); quassia, quina (Braz.); echtes quassiaholz, fliegenholz,[123] bitterholz (Germ.).

[123] Refers to use of the wood as a source of fly poison.

PICRAENA

This genus, often included in the genus *Picrasma*, consists, in this restricted sense, of three or four species of small tropical American trees. The best known is the West Indian bitterwood or Jamaica quassia, *P. excelsa* Lindl. (= *Picrasma excelsa* Planch. = *Simaruba excelsa* DC.), which is used for the same purposes as the preceding. The tree attains a height of 40 to 60 feet, and has a straight trunk with smooth, almost white, bark. The leaves resemble those of the ash (*Fraxinus*) and the tree is often called bitter ash on this account. Although it is rather widely distributed, the bulk of the present supply of wood comes from Jamaica, entering the market in the form of logs three to 10 feet long and three to 10 inches in diameter, often knotty, and with the bark on. The structure and general appearance of the wood is much the same as in *Quassia amara*. The vessel lines are somewhat coarser and more distinct and ripple marks are present, though many of the rays occupy more than one story. *Material:* Yale Nos. 4981, 4982 (Jam.).

Common names of this and closely related species: Bitterwood, West Indian bitterwood, Jamaica quassia (Trade); lignum quassia Jamaicense (Pharm.); bitterwood, bitter ash (B. W. I.); bois amer, bois de St. Martin, bois de quassia de la Jamaïque, quachi, coache, simarouba (Fr. W. I.); kwassiehout, grammam kwassie, bitteresche (Sur.); fresno amargo (Col.); palo amargo, quina brava (Arg.); quassiaholz von Jamaica, bitterholz von Jamaica (Germ.).

SIMARUBA (SIMAROUBA)

This genus consists of seven or eight species of tropical American trees, some of which are large. The paradise tree or bitterwood of southern Florida, *Simaruba glauca* DC. (= *S. officinalis* Macf.), has a range including Cuba, Jamaica, Brazil, and Nicaragua. It is a tree of medium size, occasionally 50 feet high, with rounded top and a straight trunk rarely 18 to 20 inches in diameter, and is one of the most ornamental of all the tropical trees in Florida. The lustrous white, yellowish, or slightly brownish wood is light and soft (sp. gr. 0.41), easy to work, weak, bitter, inodorous, and not durable.

The "páo parahyba," said to be *S. versicolor* St. Hil., grows to a height of 100 feet and a diameter of 24 inches in Bahia, Brazil. According to the Rebouças,[124] this tree, which is the same as the "caixêta" (a name presumably referring to the use of the lumber for boxes and accordingly applied to various other woods of that type), is common throughout

[124] Rebouças, André e José: *Ensaio de indice geral das madeiras do Brazil*, Rio de Janeiro, 1877, p. 214.

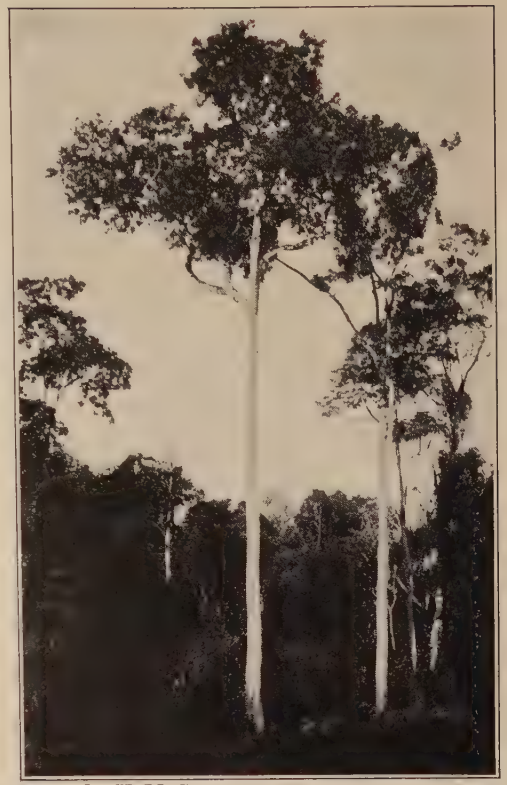


Photo by H. M. Curran.

The Guatambú of Argentina.

(*Balfourodendron Riedelanum.*)

Photo by C. D. Mell.

The Jamaica Quassia.

(*Picraena excelsa.*)

PLATE XXXII

Brazil, and attains a height of 60 to 65 feet and a diameter of six to 10 feet. The wood is described as uniform-textured, white or with black spots sometimes in old timber, specific gravity 0.46 to 0.50, resistant to insects; a second-grade material used for doors and sheathing and, in Bahia, for wooden shoes. According to Bertin,[125] the "caixêta," doubtfully referred to *S. versicolor* St. Hil., is a symmetrical tree about 30 feet high and from 24 to 32 inches in diameter, with a firm, whitish wood, specific gravity of 0.40 to 0.56, very easy to work, good for carving, and used for interior works not requiring great durability; also suitable for paper pulp. Other common names given are "páo parahyba" and "malacacheta."

Regarding the trees of this genus in the Amazon region of Brazil, Huber[126] says that the "marupá," *Simaruba amara* Aubl., is a tall tree very common in the forests of the Bragança Railroad and in the southern part of the state of Pará, furnishing an extensively used white wood. The "marupaúba,"[127] probably *S. amara* Aubl. var. *opaca* Engl., is a tree of rapid growth, yielding a wood that is light, soft, easy to work, and immune from attack of insects, presumably on account of the bitter taste. It is used principally for house sheathing, boxes, etc. "Marupá" lumber is now entering the New York market in considerable quantities and is being used in the manufacture of organ pipes, piano keys, patterns, and for interior trim that is to be painted. The stock is subject to blue stain in transit, but this does not affect its strength and can be prevented. It is said that "marupá" logs are likely to split open in sawing and boards may also split from end to end in drying.

The "marupá" of Brazil is supposedly the same species as the "simaruba" of the Guianas. The latter grows to large size on sandy soil, reaching a height of 90 to 100 feet with a clear trunk sometimes three feet in diameter. The timber is not durable when exposed to the weather, but is resistant to insects and is used for interior construction. It is also the principal wood used locally for match sticks.

THE WOOD

Simaruba amara Aubl. *Simaruba.*

Common names: Simaruba, simarupa, maruba, aruba (B. G.); soemaroepa, walkara, adoonsidero (Sur.); simarouba, acajou blanc, bois blanc, bois de Cayan (Fr. W. I.); marupá, marupaúba, marubá (Braz.); simarruba (Col.);

[125] Bertin, A.: Les bois de la Guyane française et du Brésil, *Miss. For. Col.*, V, Paris, 1920, p. 292.

[126] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:186 (1909).

[127] The names "marupá" and "marupaúba" are applied also to white-wooded trees of other families, *e.g.*, *Jacaranda Copaia* (Bignoniaceae) and *Didymopanax Morototoni* (Araliaceae).

Brazilian white pine. Other species: Parahyba, páo parahyba, paraïba, pé de perdiz, caixêta, caixêta branca, malacacheta, marupá-rana, caju-rana, pitombeira de Marajo (Braz.); paradise tree, bitterwood (Fla.); bitter damson, bitter dan, mountain damson, stavewood (Jam.); palo blanco, simaruba (Cuba); olivo (Pan.); simaruba (C. R.); acietuno negrito (Nic.); acietuno, jucumico (Salv.); xpaxakil (Mex.).

General properties: Color yellowish-white or straw-colored; uniform except for occasional oily streaks; is subject to blue stain. Sapwood not clearly defined.

Odorless. Taste bitter, but less so than in *Quassia.*

Light but firm. Sp. gr. (air-dry) 0.40. Weight about 25 lbs. per cu. ft. Grain usually straight. Texture rather coarse to medium. Wood as easy to work as white pine (*Pinus Strobus* L.). Does not warp or check, holds its place, glues up well, and is easy to stain, paint, or varnish; resistant to insects, but not to decay.

Growth rings: Absent or indistinctly marked by parenchyma lines and sometimes by gum ducts.

Parenchyma: Fine, irregular, white lines connecting pores; sometimes more or less concentric, fairly abundant and distinct, sometimes only as wings to pores and much less distinct, scarcely visible on longitudinal surface.

Pores: Variable from rather small to rather large; distinct; open, fairly numerous to comparatively few; evenly distributed; solitary or subdivided radially.

Vessel lines: Usually long, straight, and very distinct, appearing darker than background.

Vessel contents: Some contents of a gummy nature noted.

Rays: Fine and inconspicuous, but visible without lens on all sections; storied.

Gum ducts: Usually present. Few to many vertical ducts of normal occurrence in narrow tangential series; sometimes widely spaced, and may be absent in small specimens. Oily contents produce prominent streaks on surface of wood.

Minute anatomy: The vessels have simple perforations. The pits between vessels and parenchyma are rather large and round, half-bordered. The rays are homogeneous or nearly so, one to five cells wide, and of variable height, in some specimens up to 100 cells. The wood fibers have numerous, irregularly disposed pits with a long slit-like aperture extending beyond a distinct circular border.

Remarks: The wood specimens from British Guiana, Surinam, and various parts of Brazil are much alike in structure and properties. A specimen (Yale No. 4062, labeled "balsam") from commercial sources, origin unknown, has the typical structure and bitter taste of this group, but resin or oil ducts are absent and ripple marks are of only local occurrence.

Tests on "páo parahyba," obtained by Mr. H. M. Curran in Bahia, gave the following results: Sp. gr. (oven-dry) 0.388. Weight (7.62 per cent moisture) 25.3 lbs. per cu. ft. Crushing strength parallel to grain, 4120 lbs. per

sq. in. Bending: Modulus of elasticity, 1,289,900; fiber stress at elastic limit, 7720 lbs. per sq. in. Fabrication tests showed that the wood is not well suited for turning, owing to "a decided tendency to twist off and chew up in the machines."[128]

Material: Yale Nos. 4183 (Sur.); 4199, 4221 (B. G.); 1777*, 3423, 3482, 3931, 4043, 4691*, 5351, 5911, 5923 (Braz.). Asterisk indicates botanical material.

31. SURIANACEAE

The Bay Cedar Family, often included in the Simarubaceae, consists of a single genus and species, *Suriana maritima* L., usually a shrub but sometimes a small tree occurring along the seacoast throughout the tropics of both hemispheres. The branches are thick and velvety and the few yellow flowers are borne in short clusters. The common names are: Bay cedar, tassel plant (Bah.); cuabilla (Cuba); gitarón, temporana (P. R.); palo corra (Curaçao).

The heartwood, of a mahogany-red color merging into the light-colored sapwood, has no characteristic odor or taste, is hard and heavy, very fine-textured, and takes a high polish. The growth rings are poorly defined, though indicated by slight differences in density and color. The pores are invisible without lens, not very numerous, occurring mostly in radial groups of two to several. The vessel lines are very fine; mostly dark red, due to gummy contents. Parenchyma is scanty and not visible. The rays are extremely fine and numerous, scarcely visible with lens on cross and tangential sections, and indistinct on radial. Ripple marks are present, fairly regular, barely visible without lens, about 120 per inch.

As to the minute anatomy: The vessels have simple perforations and very small bordered pits. The rays are heterogeneous, most of the cells upright or square; uniseriate and about five cells high; gummy; pits into vessels very small and half-bordered. Parenchyma very sparingly developed. Wood fibers thick-walled; often filled with gum; pits very small, simple; interior of wall often striate. *Material:* Yale Nos. 2792* (Curaçao); 4868* (Haiti). Asterisk indicates botanical material.

32. BURSERACEAE

The Torchwood Family consists of about 20 genera and upward of 400 species of trees and shrubs of wide distribution throughout the tropics of the world. They are mostly resiniferous or aromatic and are better known on account of these properties than for their woods. The

[128] Babbitt, Will C.: Turnings from Brazilian hardwoods, *Wood Turning* (Milwaukee), 16:7:17, 19, Apr., 1923.

gum-resins which exude from the bark are collected and used medicinally and more especially for incense. The true frankincense is the product of various Arabian species of *Boswellia*, myrrh is obtained from *Commophora Myrra* Eng., a small tree of Arabia and the African coast of the Red Sea, and "gum elemi" from species of *Bursera* in tropical America.

In India are six genera, mostly trees, some of large size and of value in forestry because of the ease with which they are reproduced, the poor quality of the soil on which they will develop, or their rapidity of growth, as well as for their by-products. Of the three genera in the Philippines, the "pili," *Canarium luzonicum* A. Gray, is best known on account of its large edible nuts and its resin, the "Manila elemi" of commerce; while the "bogo," *Garuga* spp., is a rare wood of a reddish variegated color, used for interior finish and cabinetwork. Some of the African timbers of this family are sold on the market as mahogany or walnut. There are several genera in tropical America, but only two, *Protium* and *Bursera*, are well known.

The best known woods of this family are rather light, soft, and perishable and are at present poorly esteemed, though it is not unlikely that they will prove of considerable value in the future, especially for box boards, cheap construction lumber, plywood, and possibly for paper pulp. A few other kinds are moderately hard and of good quality.

The vessels have simple perforations and large, often crowded, bordered pits. The rays are large-celled, typically heterogeneous, and where in contact with the vessels have very large, often elongated, simple or half-bordered pits. The fibers are generally thin-walled, often septate, and in the sapwood frequently contain starch grains. Resin ducts have been observed in the rays of *Bursera*, *Santiria*, and *Garuga*, and vertical canals of traumatic origin have been reported in *Canarium* and *Protium*.

PROTIUM (ICICA)

This genus, with about 50 species, is widely distributed in tropical America, with a few representatives in the eastern tropics. Huber[129] says that the genus *Protium* contains some large trees in the Amazon region, where they are known by the names of "breu branco," "breu sucuriú," etc., but they are valued more on account of their resins than for their little-used woods. The "breu branco," *Protium heptaphyllum* March., is a species best known in the State of Pará. Its white and fragrant resin enters the world market under the name of "elemi."

The "almesca ussú," *Protium* sp., of Bahia, is a tree 90 to 100 feet

[129] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 186 (1909).

high with a well-formed trunk two to three feet in diameter. The wood (Yale Nos. 1942, 3953) resembles birch (*Betula lenta* L.), is rather hard, heavy, and strong, straight-grained, fine-textured, fairly easy to work, finishes smoothly, and the heart is of a reddish-brown color, sometimes with a golden luster, while the sapwood is pinkish and sharply defined. It is used for general construction and is apparently suited for all the purposes to which we apply birch.

Closely related to these is the "anime blanco" of Colombia, probably *P. heptaphyllum* March. The specimens available (Yale Nos. 1546, 2555, 2572) are apparently all sapwood and are of a rather lustrous pinkish-white or oatmeal color and vary in density from hard and heavy to only moderately so. The rays are scarcely visible on the cross section, but because of their deeper color show as very narrow ribbons on the radial surface, and give a finely flecked appearance to the tangential. The resin is called "tacamahaca" in Colombia and Venezuela. Where this tree grows the whole air for some distance around is pleasant and wholesome with the incense-like odor of the white resin that drops from wounds in the stem and falls in masses to the ground. The Indians use the resin to scent the oil with which they anoint themselves. The timber of an unknown species of *Protium* is used by the Dutch settlers in Colonia Tovar for beams and shingles.

The information regarding these trees in the Guianas is badly confused, due probably to the fact that they are commonly referred to as some kind of cedar, a name derived from the fragrance of the resin in the bark and possibly also in the fresh wood. According to Bertin,[130] the "encens rose" or "ya-ya," *Protium* sp. ?, of French Guiana is a rather rare tree, 60 to 80 feet high and from two to three feet in diameter, yielding a wood of a somewhat variegated rosy-orange color, with a white sapwood, and having a fragrant scent when freshly cut. The wood is moderately heavy, fairly easy to split and to work, fairly durable, and suitable for carpentry and joinery and interior work of various kinds. The resin, which exudes freely from the bark and hardens upon exposure to the air, has a strong odor of incense; whence the name of the tree. *Material:* Yale No. 5379; Bertin's No. 3017.

The so-called white cedar of British Guiana is said to be *P. altissimum* March. (= *Icica altissima* Aubl.), a tree of rather extensive distribution in northern South America. The wood is pale brownish, lustrous, and rather light and soft, though firm, suggesting gray birch (*Betula populifolia* Marsh.). The bastard cedar, incense tree, or "hiawá" of British Guiana is *P. heptaphyllum* March. (= *I. hepta-*

130 Bertin A.: Les bois de la Guyane française et du Brésil, *Miss. For. Col.*, 5: 91-92 (1920).

phylla Aubl.), and presumably the same as the "tacamahaca" of Colombia and Venezuela.

The only available wood specimen of this group that is specifically identified is that of *Icica panamensis* Rose, a small or medium-sized tree growing in the sparsely forested hillsides, along the Atlantic coast of Panama. It is known locally as "copá," perhaps an alteration of "copal." The resin which exudes from the bark is used medicinally and also as incense in the churches. The wood is little used; its structure is very similar to that of the other available material.

THE WOOD

Icica [*Protium*] *panamensis* Rose *Copá.*

Common names: Copá (Pan.). Other species: Almecega, almecegueira, almescega, almesca ussú, breu branco, breu jauaricica, breu preto, elemi, icicariba (Braz.); anime blanco, anime comino, guacamayo, guacharaco, tacamahaca, tacamocha, tacomhaca, urrucay (Col.); chutra (Pan.); copal, pom (Mex.); caraña, tacamahaca, cabimbo, caricari, caricaro, cedro dulce ?, guacamayo (Venez.); acouchini, barada-balli, bastard cedar, haiawá, haiowá, hiawá, hyawá, hyawana, incense tree, kurana, oloo, olu, oolu, white cedar (B. G.); ayawa, bagasse, bois cochin, bois d'encens, bois encens, bois de rose femelle, caragne blanche, cèdre bagasse, cèdre blanc, encens, icicariba, iciquier cèdre, jaowa, ya-ya, youcamoney (Fr. G.); soly, tienjie monnie, tingi monnie (Sur.); arouaou, chipa (Galibis); gommier blanc, gommier jaune des carrières (Guad.); bois gommier (Mart.); copal (Cuba); samaria wood ?.

General properties: Sapwood of oatmeal color; no heartwood in specimen, but in a closely related wood the heart is brown with a golden luster.

Odor and taste not distinctive in dried specimen.

Wood rather light, but fairly hard. (Other woods of this genus vary from rather soft to decidedly hard.) Grain straight. Texture medium. Wood stiff, moderately strong, easy to work, takes smooth finish; does not look durable. (Darker-colored heartwood of other species appears fairly durable.)

Growth rings: Poorly defined; occasionally fairly distinct, due to slight differences in density and color.

Parenchyma: Sparingly developed; not distinct with lens.

Pores: Small; not very distinct without lens; fairly numerous, but not crowded; well distributed; occurring singly or appearing subdivided radially two to several times; open.

Vessel lines: Fine and indistinct.

Vessel contents: Few tyloses present.

Rays: Invisible or nearly so on cross section; faintly visible on tangential, producing finely mottled appearance; low, but very distinct, on radial surface, appearing considerably darker than background.

Ripple marks: Absent.

Gum ducts: None observed. Resin ducts in bark. There are resin ducts in

the rays of the "encens rose" from French Guiana (Yale No. 5379; Bertin's No. 3017); this wood may be *Bursera.*

Remarks: The only important difference noted in the various specimens of *Protium* spp. is in the density.

Material: Yale Nos. 2999 (collected by Dr. Pittier in Panama; his No. 4082). OTHER SPECIES: 1546, 2555, 2572 (Col.); 5269 (Venez.); 1942, 3953 (collected by Curran in Bahia, Braz., the latter with leaf specimens).

BURSERA (ELAPHRIUM)

This genus consists of about 80 species of trees and shrubs widely distributed in tropical America, especially in the West Indies, northern South America, Central America, and Mexico, with two species reaching the United States. One of these is *Bursera microphylla* A. Gray, a short tree with a stout trunk in southern California and northern Mexico; the other is the gumbo limbo or West Indian birch, *Bursera Simaruba* (L.) Sarg. (= *B. gummifera* Jacq. = *Elaphrium Simaruba* Rose), the most widely distributed and best known species with a range extending from southern Florida southward throughout the West Indies, Mexico, Central America, Colombia, and Venezuela. According to Sargent,[131] it reaches a height of 50 to 60 feet, with a trunk 30 to 36 inches in diameter, and is "one of the largest and most common of the south Florida trees, and the only one which sheds its foliage during the autumn and winter."

The West Indian birch or "almácigo," as it is commonly known to the Spanish-speaking people, is one of the commonest trees of the West Indies and is readily recognized by its smooth, lustrous, copper-colored bark that peels in papery shreds resembling the yellow birch (*Betula lutea* Michx.). Small stems and branches are commonly used for fence posts and usually take root and develop into trees. The fact that the tree is so easily reproduced and will grow vigorously in limestone soils, no matter how rocky or barren these may seem, makes it of interest to the forester, though it is generally classed as a tree weed, because its wood is soft and sappy and quickly attacked by mold and rot if not promptly dried, a difficult feat under the prevailing conditions. With the introduction of modern methods of logging, sawing, and kiln-drying, a serviceable grade of box and crating lumber could be readily and cheaply produced.

In Haiti there are nearly pure forests of the almacigo or "gommier" covering thousands of acres and beyond these the trees occur more or less abundantly. The railroad runs through the best portions of these forests, making it possible to bring millions of board feet of the logs to

[131] SARGENT, C. S.: *Manual of the trees of North America,* 1922, pp. 646-647.

a centrally located sawmill. During the war a local soap factory shipped all of its product in boxes made of this wood and found them entirely satisfactory. The chief problem in the successful utilization of this timber is that of drying it properly and quickly enough to avoid staining.

It is in Cuba that the tree attains its best development. In open places the trunks are usually rather short and often crooked, dividing to several heavy branches which form a large open crown; in the forest it grows straight and symmetrical with clear lengths of 35 to 40 feet and diameters of three to five feet. The somewhat drooping pinnate leaves are from six to 12 inches long, with leaflets three to four inches long; the flowers are small and of a light yellowish color; the fruit, which is borne in clusters, is a kind of a berry about a quarter-inch in diameter. It grows best on lands suitable for sugar cane and sometimes constitutes fully a fourth of the volume of the stand over considerable areas, with diameters usually of 18 to 24 inches.

It is the commonest, best known, and most characteristic tree of Porto Rico, especially on the south side of the island, and is found everywhere along the improved roads, probably developed from cuttings originally set for fence posts. It is not an unusual tree along the Spanish main from southern Mexico to Colombia. It also attains large size in the hot lands as well as in the more interior portions of Costa Rica, and Dr. Whitford collected it along the eastern part of the Guatemala-Honduras boundary, where it was abundant in the second-growth forests. Mr. Curran collected the same or very similar species in Pernambuco, Brazil, under the name of "imburana," which is commonly applied to *Bursera leptophloeos* Mart.

THE WOOD

Bursera Simaruba (L.) Sargent — *Gumbo Limbo.*

Common names: Gumbo limbo, gum elemi, West Indian birch (Fla., B. W. I.); mastic, mastick, mastick tree, chibou, resin plant, large gummier, gum-bearing bursera, gum elemi tree (B. W. I.); Jamaica birch (Jam.); gamolomie, gommo limo (Bah. negroes); almácigo (Sp., gen.); almácigo amarillo, almácigo blanco, almácigo colorado, cachibú (Cuba); gommier (Fr., gen.); gommier gris, chibou, cachibou, gomard, gommart des Antilles, gommart de l'Amerique, bois de gommier blanc (Fr. W. I.); almácigo encarnado, jiñicuite, jiñocuabo (P. R.); caraño, gommier (Trin.); caricarito, mara blanca, mara colorada (Curaçao); indio desnudo (Venez.); chibou, resbala mona, jiñocuavo (Col.); jiñocuave, jiñocuavo, jinote (C. R.); jiote, palo de jiote (Salv.); chinacahuite, chino, copón, jicote, jiote, mulato, palo chino, palo jiote (Hond.); chaca, jiote, mulato, palo colorado, palo jiote, palo mulato, piocha, quiote, torote, xioquauitl, zongalica (Mex.). OTHER SPECIES: Chutama, cirujano, copal, c. amargo, c. amargoso, c. blanco, c. chino, c. de

penca, c. santo, copalquahuitl, copalquin, copalxochitl, cuajiote, c. amarillo, c. chino, c. colorado, c. verde, elemi de Mexico, goma de limón, inanué, incienso del país, jaboncillo, linaloé, linalué, nabanche, ngedi, ngidi, palo copal, papelillo, sisiote, sochicopal, suchicopal, tacamaca, tecomaca, teponaxtle, teponaxtli, teponaztli, tetlate, tetlatía, tetlatián, tetlatín, torote, t. blanco, t. prieto, xochicopal (Mex.); caraña, carate, caratero, crispin, sasafrás (Col.); bálsamo, caricarito, incienso, mara blanca (Venez.); imburana, imborana, imborana de espinho (Braz.).

General properties: Wood whitish or light brown; usually discolored blue. Sapwood not distinguishable from heart.

Odor and taste absent or not distinctive.

Wood light, fairly soft, but firm and tenacious. Sp. gr. (oven-dry) 0.30 (Tenth Census). Weight 30 lbs. per cu. ft. Grain fairly straight to irregular. Texture medium to coarse. Wood fairly strong, easy to work, not so easy to split, feels somewhat harsh, finishes fairly smoothly; very perishable.

Growth rings: Absent or indistinct.

Parenchyma: Sparingly developed; not visible.

Pores: Medium-sized to small; visible, numerous; well distributed; occurring singly or frequently in radial groups of two or three; open.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Fine; invisible or nearly so on cross section; faintly visible on tangential; distinct, but not conspicuous, on radial surface.

Ripple marks: Absent.

Gum ducts: Common in rays; show as black dots under lens.

Remarks: The "imburana" (Yale Nos. 3410, 3415) of Bahia, Brazil, is a wood of much better quality, being finer-textured and harder; the color is yellowish, deepening to brown or light reddish-brown superficially; tyloses are present. It is somewhat different from the "imburana" (Yale No. 3418) from Pernambuco.

Material: 3677* (Guat.-Hond.); 1542 (Col.); 2135*, 2140*, 2781*, 2851* (Curaçao); 4988 (Cuba); 5218*, 5219* (Florida). Asterisk indicates botanical material.

MISCELLANEOUS

There are a few species of *Hedwigia* (*Tetragastris*) ranging from the West Indies to Central America. *H. balsamifera* Sw. is a medium-sized to rather large tree of fairly common occurrence in the mountainous regions, and is said to yield a fine-textured, fragrant, yellowish or rose-colored wood of good quality. The only specimen available (Yale No. 4658 from P. R.), presumably of this species, is decidedly cross-grained, without fragrance, and resembles *Protium*. The tree yields a fragrant balsam. The common names are: Masa, masa colorada, palo de aceite, palo de masa (P. R.); azucarero, azucarero de montaña, palo cochino, palo de cochino (Cuba); gommier, bois cochin, bois à flambeau,

bois de gommier rouge, bois à barriques, palo cochin, sucrier de montagne (Fr. W. I., Fr. G.); encens (Guad.); azucarero del monte, palo de marrano, palo de cerdo (Col.); copal (C. A.).

Dacryodes excelsa Vahl grows gregariously in the mountains of Porto Rico, where it reaches a height of 60 to 75 feet with a symmetrical trunk three feet or more in diameter, and yields a fine-textured, lustrous brown wood of good quality with many local uses. The resin is used as incense, for medicine, and also as an illuminant. No authentic wood specimens are available for study. The common names are: Tabanuco, tabonuco (P. R.); candle wood (B. W. I.).

33. MELIACEAE

The Mahogany Family consists of about 40 genera and over 600 species of trees, shrubs, and woody herbs widely distributed throughout the tropics of both hemispheres; a few species are extra-tropical. Among the valuable timbers supplied by this family are the true mahogany and the Spanish or cigar-box cedar of tropical America; most of the so-called African mahoganies; the Australian rosewoods; the bead tree, "toon," and Chittagong wood of India; the "calantas" and other excellent timbers of the Philippines. There are six important genera in tropical America, namely, *Cedrela*, *Swietenia*, *Carapa*, *Cabralea*, *Guarea*, and *Trichilia*. The mahogany, *Swietenia Mahagoni* Jacq., occurs in southern Florida and is the sole representative of the family indigenous to the United States, though the China tree or bead tree, *Melia Azedarach* L., is sparingly naturalized in the southern states.

Although the woods of the different genera exhibit considerable variation, they are for the most part reddish in color, often fragrant, durable, and highly esteemed for cabinetwork. The cedars (*Cedrela* and *Toona*) are the most useful timbers in the tropics, where they serve the same purposes as the pines do in the north temperate zone. The most famous member of this family, however, is the mahogany, one of the first American timbers to attract the attention of Europe and holding ever since a commanding position among the cabinet woods of the world.

CEDRELA

This genus, in a restricted sense, consists of more than 30 species of important tropical American timber trees. It has its counterpart in the *Toona* of the Far East, a genus so closely related to *Cedrela* that some botanists do not accord it generic rank. The woods of the two groups are very much alike in all of their properties, being of a pinkish or reddish color, soft, easy to work, highly durable, and fragrant. Because

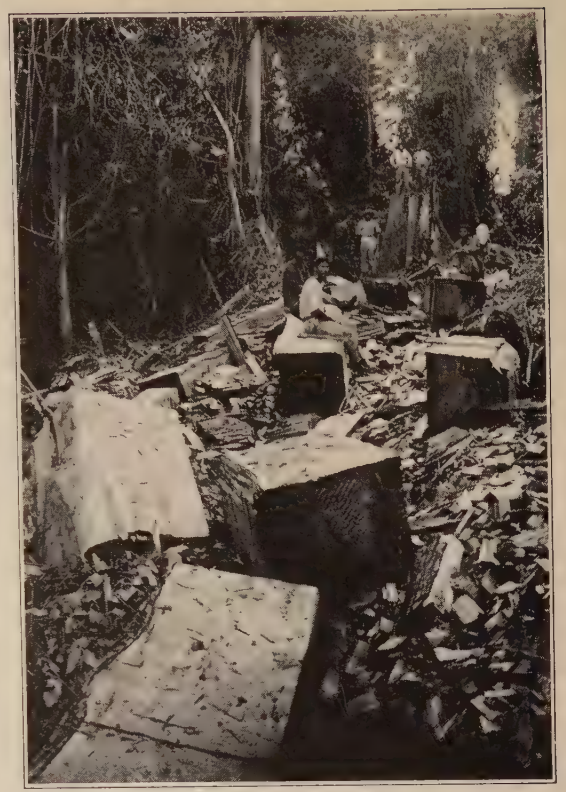
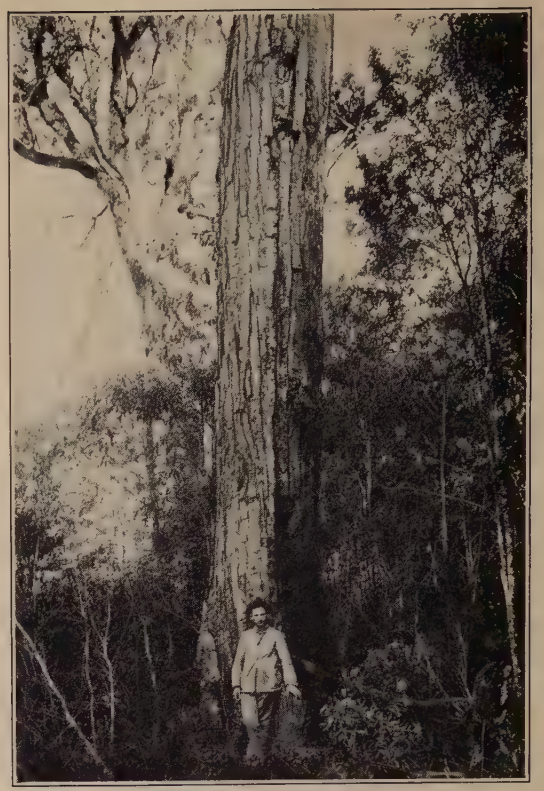


Photo by C. S. Rogers.

Spanish Cedar in Trinidad.

(Cedrela sp.)



The Cedro of Southern Brazil.

(Cedrela sp.)

PLATE XXXIII

of their fragrance the trees and woods are generally known as cedar[132] (English) or cedro (Spanish and Portuguese).

The first species, *Cedrela odorata* L., was described by Linnaeus in 1759, and was formerly credited with a very much wider range than is now accorded it. It is the original Spanish cedar and the type of the group of 33 other species (some of which may prove to be only varieties) subsequently described by various authors. It is impossible, with our present knowledge, to distinguish the woods of the different species of *Cedrela*, for although they exhibit considerable range in their structure and physical properties, it remains to be determined to what extent these variations are attributable to the age and conditions of growth of individual trees. The wood of young trees, especially those of very rapid growth in the open, is less fragrant, of lighter color, and softer, though tougher, than that of old forest-grown trees. Some of the densest cedar timber is much like certain grades of mahogany (*Swietenia*), for which it is not infrequently substituted.

The natural range of cedar probably exceeds that of any other tropical American tree; it includes all of the islands of the West Indies, every country in South America except Chile, all of Central America, and the southern half of Mexico. Unlike many other tropical trees, however, it is not represented in the native flora of southern Florida. The trees attain stately proportions in the forest, often with heights of 80 to 100 feet and diameters of three to six feet and in rare instances as great as 10 feet. The old trees are buttressed to a height of six to ten feet, but the trunks above are usually straight and cylindrical and free of branches for from 40 to 60 feet. The leaves are large and pinnately compound, as in walnut (*Juglans*); the flowers are inconspicuous; the fruits are capsules which upon opening liberate great quantities of small winged seeds.

The wood is noted for its fragrance, durability, ease of working, stability, and for its great strength in proportion to its weight. It does not split easily, can be readily sliced into very thin veneers, and takes glue better than most other woods. The characteristic figure consists of a series of dark lines on a red background, but sometimes the wood is roe-grained, and that of the buttresses and burls is highly figured.

A volatile oil, oil of cedrela wood, is present in quantities varying from 0.5 to 3 per cent, and it is to this that the wood owes its fragrance

[132] The name "cedar," originally applied to species of *Cedrus*, a small group of trees growing in northern Africa and western and southern Asia, has been gradually extended until it now applies to at least 50 different kinds of both coniferous and broad-leaf trees. As used in the trade the name has no botanical significance, and some of the woods so called are not fragrant.

and probably also its resistance to decay and to insects. It is due to this fragrant oil, also, that the lumber is so highly esteemed for the manufacture of cigar boxes, its principal use outside the locality of the growth, since it is claimed that the fragrance of the cedar wood imparts a very desirable property to the tobacco. The tendency of the oily vapors to condense on cold surfaces renders the lumber unsuited for the manufacture of cabinets or cases to contain glassware or metallic instruments.

Cedar has very extensive applications in the tropics, being used for carpentry and construction work of all kinds where a light and durable material is needed. The demands of the world's markets are heavy and are constantly increasing. About 10,000,000 board feet are consumed annually in the United States. The supply of accessible virgin timber is being depleted and no provision is being made anywhere to meet the demand, say, fifty years hence. The rapidity of growth of cedar, the ease with which it is propagated, and the ready market for the timber, combine to make the tree the most valuable of all for commercial planting in the tropics. The comparatively few plantations already established in the West Indies, Mexico, and various parts of South America are sufficient to demonstrate their feasibility under a wide range of conditions. Although companies have been organized to plant *Eucalyptus* and the so-called Australian pine (*Casuarina*), timbers without established markets, little or nothing has as yet been done to grow cedar on a commercial scale.

Young seedlings spring up naturally on cleared land and cut-over areas and were it not for the recurrent fires so common in the regions, would be able to maintain an important place in the second growth. The trees are unable to withstand much shade and the conditions in the dense forests from which only the scattered cedar trees are removed are unfavorable to the natural regeneration of the species, the heavy jungle growth making the reestablishment of cedar an extremely slow process. If left unattended the natural regrowth cannot be depended upon to meet the increasing local and export demands for this timber.

The methods of logging are for the most part very crude and also very wasteful, since only the better class of material is worth the trouble and cost of getting it to market. The introduction of modern machinery and logging methods has not met with success where cutting is confined to one kind of timber scattered through the forest in rough and hardly accessible places. It has been the general experience of cedar operators that the primitive methods to which the native laborers are accustomed involve the least expenditure and, in the long run, prove the most satisfactory. In selective logging in the tropics it is generally safe to assume

that the more primitive the methods the more cheaply the logs can be produced. This explains in large part why Cuban cedar is the highest priced while that of the Amazon region of Brazil is the lowest.

The principal countries now producing cedar for export are Mexico, Central America, Brazil, Cuba, and Trinidad. Limited quantities are also obtained from other South American countries, though most of their product is used locally.

Cuba. Cuba was the first country to ship cedar to the United States and has continued to supply large quantities regularly. Following the American occupation the amounts were materially increased and were from four to eight million feet a year prior to 1914. Cedar exports from Cuba have fallen off since the World War, partly on account of a larger local demand by cigarmakers and more especially because of the much higher costs of all of the logging operations which have made it increasingly difficult for the operators to meet the competition of cedar from other countries.

Trinidad. Cedar has been exported from Trinidad for many years. Just prior to the war nearly all of this timber, amounting to about a million feet annually, was shipped to Hamburg and the demand was chiefly for logs about five feet long and squaring from 20 to 40 inches, the price being about 65 cents per cubic foot, port of Spain. More recently a larger percentage of small logs have been shipped, the bulk of the timber going to England and small quantities to the United States. Most of the timber readily accessible to the railroad has been cut, but considerable quantities still exist in the remoter parts of the island.

Mexico. Spanish cedar is much used locally in Mexico and large quantities are annually exported. American dealers did not enter this field to any great extent until shipments from Cuba were interrupted by the Spanish-American war. Since that time shipments have been made regularly, usually in conjunction with mahogany. Mahogany operators usually take out cedar logs also when they are within easy reach of the trails, and the American importer is usually willing to accept 10 per cent of cedar in a cargo of mahogany. The annual exports of cedar from Mexico are between three and four million feet. Most of it emanates from Gulf coast ports; that from the west coast is largely for the San Francisco market. The timber is of excellent quality and commands the best prices.

Central America. More cedar is exported from Central America than from Mexico, the bulk of it coming from the east coast of Nicaragua

and the west coast of Costa Rica. The timber from the east coast is chiefly in the form of round logs floated down the rivers during the rainy season from June to December and shipped with mahogany. On the west coast, owing to the unsuitability of the streams for floating, the logs are hewn square in the forest and hauled out on ox-carts during the dry season from December to May.

Panama has produced very little cedar, but there are considerable quantities along the southern slopes of the Continental Divide and about the headwaters of the Chagres River.

Colombia and Venezuela. Colombia produces comparatively little cedar for export, though occasional shipments are made to Porto Rico. The logs offered are too small to meet the requirements of the American market. Mr. Curran says:

> Though once fairly abundant, cedar is no longer found in quantity in Colombia. It has been culled from the forests of the Magdalena, Cauca, and other valleys of the northern part of the country for over 300 years. Its rapid growth and free-seeding permit it to occupy arid and cut-over lands so that the normal growth is sufficient to meet current local needs in a measure, though supplying no timber for export. During a recent examination of property near the junction of the Cauca and Magdalena Rivers the cedar found was very largely second-growth and the few forest grown specimens remaining bore the brands of various claimants who based their ownership on the right of discovery. It is not uncommon to meet oxen on the trails, many miles from the nearest settlement, dragging cedar boards that had been sawn out by hand.
>
> Conditions are practically the same in Venezuela, and while cedar lumber is a constant factor in the market, the accessible timber is apparently even scarcer than in Colombia. The trees grow very rapidly in the high mountain regions about Caracas and the vicinity of Lake Valencia; they are planted for shade in the cities and in the coffee plantations. Some commercial plantations have also been established along the right-of-way of the Caracas and Valencia railroad.

There is no incentive to export cedar as the logs command a better price in the local markets than in New York or Liverpool.

The Guianas. There is considerable cedar in Surinam available for export, but at present there is little demand for it except at prices too low to justify shipping, as the dealers claim that the logs are somewhat more defective than those obtainable from other regions. It is probable, however, that the business will develop later.

There is not much cedar in British Guiana and the limited production is consumed locally. Small shipments were formerly made out of the Northwest Province, but the business has been abandoned.

Brazil. Cedar is a very common tree in the Brazilian forests and the wood is highly esteemed and much utilized locally. It is more abundant in the sub-tropical forests of the southern part of the country than in the coast region. Regarding the latter, Mr. Curran says: "The cedar trees reach a height of 100 feet, with diameters of three or four feet and clear lengths of 50 feet. They are slightly buttressed, but otherwise the trunks are cylindrical and covered with a rather rough, gray or reddish bark suggesting chestnut (*Castanea*). Sometimes the logs are whip-sawn into boards in the forest and dragged by animals to the nearest floating point or to the homes of the local users. If the trees are near streams the logs are squared and floated to tidewater or to places where they can be made into rafts for floating down the rivers; arrived at tidewater, they are loaded on steamers and carried to the principal coast markets of eastern Brazil."

As to the Amazon region, Huber[133] says that there are various poorly known species growing on both the uplands and the flood plains throughout that territory, being especially abundant along the larger tributaries to the south, where the flood waters cut into the banks and precipitate the trees into the rivers. Along the Madeira River and near its mouth are sawmills which operate almost exclusively on cedar brought down by the freshets. Along the southern tributaries of the Pará estuary the loggers fell the trees near the rivers and raft the logs to the mills or ports of shipment. Various kinds of wood are popularly distinguished by the names "cedro branco," "cedro vermelho," "cedro do Amazonas," etc.

Shipments of Amazon cedar from Manaos or Pará to the United States are now of regular occurrence, and nearly every ship sailing from those ports carries cedar to the limits of its available space. The logs are usually in the round and are well formed and of good appearance; the former objection to the wood on account of its gum content has been largely overcome by improved methods of seasoning the lumber. Brazilian cedar is now well established in the American and European markets.

Argentina. Mr. Curran says:

The exploitation of cedar is the second largest lumbering operation in Argentina, ranking next to that of quebracho (*Schinopsis*). The principal sources of the timber are the forests of Misiones and the adjacent regions of Paraguay and Brazil. The trees are from 85 to 100 feet in height with cylindrical boles free of branches for 50 or 60 feet and ranging in diameter

[133] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi,* 6:186 (1909).

up to four feet, though the usual sizes of commercial timber are between two and three feet.

The cedar forest is a mixture of various hardwoods, among which are "lapacho" (*Tecoma*), a form of "curupay" (*Piptadenia*), "timbó" (*Enterolobium*), "mora" (*Chlorophora*), "petereby" (*Cordia*), "incienso" (*Myrocarpus*), and "virarú" (*Ruprechtia*), all of which are included in the logging operations. Cedar has been culled from these forests from the earliest settlement of the country, but it reproduces so readily in every opening and grows so rapidly that the same ground can be re-cut at periods of 15 or 20 years. As the demand increases, the tendency, of course, is to cut smaller and smaller sizes, and, in consequence, much of the more accessible forest area is very poor in cedar.

There are several sawmills with modern equipment along the upper stretches of the Paraná River. The logs are skidded by animals to the river and floated to these mills where they are roughly squared and made into rafts which are sent down to the railway at Posadas or further down for transfer to steamers. Rafts are not permitted much below the city of Corrientes, from fear of obstructing the narrow channel. As a rule, each of the small woodworking plants buys square timber and cuts it into 2-inch flitches which are then stacked either in the open or under cover and allowed to season. This is considered more economical than buying sawn lumber, since the timber can cut to meet the special requirements of each business with consequent reduction of waste.

The local uses include furniture, wardrobes, interior fittings for banks and stores, and innumerable household articles. The heartwood of old trees is highly fragrant and of a deep red color, while the thin sapwood is pinkish, or nearly white. The wood of young trees, especially those of very rapid growth in the open, is softer, lighter colored, and less fragrant than that of old forest-grown trees.

THE WOOD

Cedrela spp. ***Spanish Cedar.***

Common names: Cedar, Spanish cedar, West Indian, Cuban, Jamaican, etc., cedar, cigar-box cedar, cedrela wood (Eng.); zedrelaholz, kistenzederholz, cigarrenholz, ciggarenkistenholz, zuckerkistenholz (Germ.); cedrela, legno di Spagna, legno di Cuba (Ital.); cedro, c. español (Span.); cedro (Port.); cedro, c. hembra (P. R.); cedro macho, c. de ramázon, c. hembra (Cuba); acajou amer, cajou senti (Guad.); acajou femelle (Mart.); leli (Curaçao); acajou à planches, bois d'acajou à planches, cèdre acajou (Barb.); acajou, acajou femelle, cèdre, cèdre odorant, cèdre acajou, cedrel, bois de cedra (Fr. G.); ceder, ceddre (Sur.); cedro dulce, c. amargo (Venez.); cedro caoba, c. colorado, c. de Bogatá, c. oloroso, c. real (Col.); cedro amarello, c. aromatico, c. batata, c. branco, c. caopiúva, c. cheiroso, c. do Amazonas, c. rosa, c. vermelho (Braz.); cedro obscuro, c. rojo (Arg.); cedro dulce, c. colorado (Pan.); cedro real, yalam (Nic.); cedro blanco, c. macho (Salv.); cedrela,

Photo by H. M. Curran.

Raft of Cedar Logs on Paraná River, Argentina.

Photo by S. J. Record.

Tangential Section of the Cedro Amargo of Venezuela (x 50).

(*Cedrela mexicana.*)

cedro chino, c. colorado, c. de la Habana, c. fino, c. hembra, c. liso, c. macho, c. oloroso, calicedra, cobano, kuché, kulché, nogal cimarrón, nogal corriente (Mex.).

General properties: Color widely variable in different specimens, being red or reddish, pinkish, light purplish, or light reddish-brown; fairly uniform in a given specimen; some woods dull, others lustrous. Sapwood pinkish, grayish, or nearly white; rather sharply defined.

With cedary fragrance and taste; much more pronounced in some cases than in others.

Variable from very light and soft to fairly heavy and firm. Sp. gr. 0.37 to 0.72. Weight 23 to 45 lbs. per cu. ft. Grain mostly straight. Texture variable from rather fine and uniform to rather coarse and uneven; sometimes woolly. Wood easy to work, finishes smoothly, holds its shape, is durable.

Growth rings: Some species are ring-porous or show tendency to become so; others are diffuse-porous, in which case the growth rings are marked by distinct line or narrow band of parenchyma.

Parenchyma: Inconspicuously about pores and in distinct line or band separating growth rings, readily visible on all sections. These concentric lines may vary greatly in the width and uniformity of the spacing, sometimes crowded locally.

Pores: Variable from rather large to very small; the larger ones are always very distinct, especially in the woods that are ring-porous. All gradations can be found, from distinctly ring-porous to wholly diffuse-porous. Pores appear open; very often subdivided; usually not very numerous.

Vessel lines: Very distinct; usually of darker color than background.

Vessel contents: Dark gum deposits common. Tyloses absent or not abundant.

Rays: Fine, but visible on all sections; very distinct on radial, where they may appear either lighter or darker than background.

Ripple marks: Absent or rarely of strictly local occurrence.

Gum ducts: Occasionally present in compact peripheral row and filled with dark red deposit. Very distinct on longitudinal sections, particularly the tangential.

Minute anatomy: Description of *Cedrela mexicana* Roem. (Yale No. 4780 from Venezuela): Vessels with simple perforations; segments barrel-shaped; pits very numerous, small, with lenticular openings. Rays heterogeneous; one to five cells wide, few to 30 cells high, the larger measuring (average) 0.35 mm. high and 0.054 mm. wide; crystals of calcium oxalate, and gum often present; pits in vessels half-bordered. Wood parenchyma in rather widely spaced concentric bands few to 15 cells wide; also paratracheal and diffuse; cells usually much larger than fibers; paratracheal cells nearly square, without distinct division into strands; gum and crystals often present. Fibers in fairly definite radial arrangement; rather thin-walled; usually septate; pits simple, small, and inconspicuous; gum deposits common; length, minimum 0.70 mm., maximum, 1.754, average of 100 measurements, 1.287 mm.

Material: Yale Nos. 2, 3, 9, 22, 30, 41, 47, 80, 107, 116, 140, 170, 175,

177, 222, 227, 256, 299, 300, 306, 2055, 6633 (Hond.); 328, 329, 463, 471, 2682, 4412, 4780*, 6660, 6661 (Venez.); 374, 375, 385, 388, 398, 410*, 411*, 504, 2562 (Col.); 520, 529, 535, 892, 893, 918, 1033, 1082, 1091, 1700, 1736, 3978, 4125, 5287 (Arg.); 593, 1928*, 1929*, 2495, 2520, 3134, 3135, 3234, 3277*, 3291*, 3892, 3920, 3930*, 4029, 4030, 4229, 4443, 4719, 4888*, 4919 (Braz.); 727, 825, 4993 (Cuba); 3031, 3035, 5109 (B. G.); 4163, 4190 (Sur.); 2742* (Curaçao); 5048 (S. D.); 2942, 4763* (Mex.); 4378 (Par.); 5241 (Nic.). Asterisk indicates botanical material.

SWIETENIA

Swietenia, with five known species,[134] is the only source of true mahogany, the premier cabinet wood of the world. It was one of the first timbers to come to the attention of European explorers and its merit for ship construction and repair was early established. Cortez employed mahogany, probably from Santo Domingo, to build the ships for further voyages of discovery after the conquest of Mexico, and it is not unlikely that mahogany timber from the West Indies or Campeche, Mexico, was requisitioned by the government of Spain for use in the Spanish Armada. Sir Walter Raleigh repaired a rudder with the wood when he was returning from Trinidad in 1595, and he is also credited with introducing mahogany into England, the popular story being that he presented a table made of it to Queen Elizabeth. The rare beauty of the wood was immediately recognized, but its use developed slowly because the material was considered too difficult to work. When it was finally demonstrated that this objection could be readily overcome by the use of properly tempered tools the demand for the timber grew rapidly.

There is evidence to the effect that mahogany was used in the construction of Nottingham Castle in 1680; and in 1743 Catesby[135] wrote: "The excellency of this wood for all domestic purposes is now sufficiently known in England. And at the Bahama Islands, and other countries,

[134] The five species and the dates when they were established are: (1) *Swietenia Mahagoni* (L.) Jacq. (1760), (2) *S. humilis* Zucc. (about 1836), (3) *S. macrophylla* King (1886), (4) *S. Candollei* Pittier (1920), and (5) *S. cirrhata* Blake (1920). The distribution, as far as is definitely known, is as follows: The first is confined to the West Indian Islands and southern Florida; the second occurs along the coast of Guarrero and Oaxaca, Mexico, and of northwestern Guatemala; the third ranges from southern Mexico through Central America into Colombia and possibly into Ecuador; the fourth is apparently limited to Venezuela; the fifth is found in Sinaloa, Michoacan, and Oaxaca, Mexico, and southward to Salvador. It is interesting to note that *S. macrophylla*, the most abundant species of mahogany in Mexico and Central America, was described and figured on the basis of trees grown in the Botanic Gardens at Calcutta, India, from seeds obtained in British Honduras.

[135] Catesby, Mark: *Natural history of Carolina, Florida and Bahama Islands*, 2: 81, 1743.

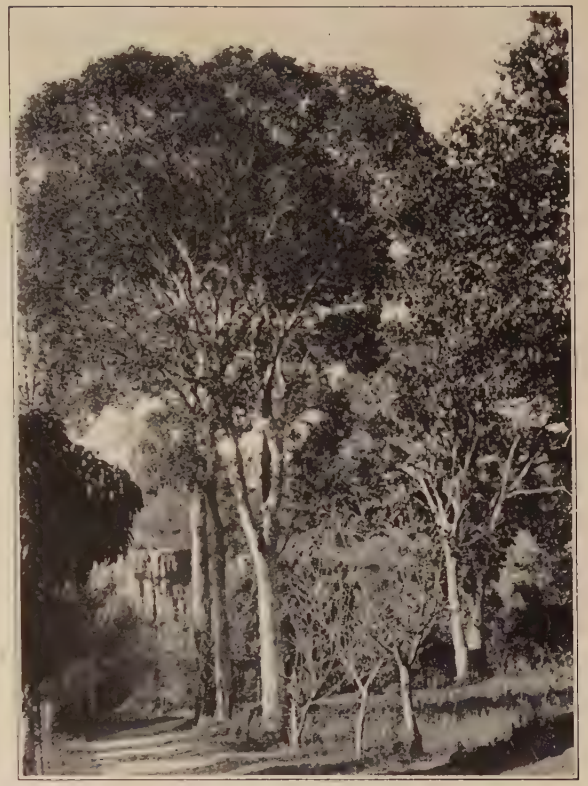


Photo by H. Pittier.

The Venezuelan Mahogany.
(Swietenia Candollei.)

Photo by S. J. Record.

Roe Grain in Mahogany.

Photo by S. J. Record.

Feather Curl in Mahogany.

PLATE XXXV

where it grows naturally it is in no less esteem for shipbuilding, having properties . . . viz., durableness, resisting gunshots, and burying the shot without splintering."

The exploitation of Honduras mahogany probably began before 1650, and by the end of the seventeenth century Belize was an important logwood and mahogany cutting settlement. In 1830 Sir William Hooker published an account of the mahogany tree, in which, after describing the extensive use of the Jamaica mahogany, he expressed his belief that a very large portion of the mahogany exported from Jamaica to Great Britain was derived from British Honduras.

The reputation of mahogany having become firmly established, exploiters of other woods began to take advantage of the name in marketing their products. The first efforts in this direction began shorty after the British conquest of India, when a number of different woods with a superficial resemblance to mahogany were shipped into England. The first African mahogany was imported into England in 1833, when 58 logs were sold in Liverpool, but it was not until about 1878 that this wood became commercially important. It is now used extensively, especially where highly figured wood in large sizes is demanded. Although various woods are now known as African mahogany, the material generally sold under this name is produced by species of *Khaya*, a genus belonging to the same family as *Swietenia*. It is the nearest approach to true mahogany of any of the substitutes.

The question is often raised as to what constitutes true mahogany. Some contend that mahogany is merely a trade name that may be applied to any wood having the attributes, particularly color and grain, of the wood originally known as mahogany, or to which such attributes may be imparted artificially. Used in this way the name loses most of its original significance, encourages fraud, and works to the serious injury of legitimate business. The woods of the different species of *Swietenia* alone are entitled to the name mahogany, regardless of the quality or characteristics of other woods masquerading under this name. The natural range of true mahoganies is confined to the West Indian Islands, extreme southern Florida, Mexico, Central America, Colombia, Venezuela, and possibly Ecuador. A shipment of logs from a region outside of this restricted territory is *prima facie* evidence that the timber is not true mahogany.

Mahogany is a stately and beautiful tree and in favorable locations attains large dimensions, being often over 100 feet in height, with a straight, symmetrical bole four to six feet in diameter above the heavy buttresses, though sometimes considerably larger, and free of branches

for 40 to 60 feet. The pinnate leaves have several pairs of leaflets that are smooth and shining above and slightly brownish on the under surface. The flowers are small and whitish or purplish and the fruits are light chestnut-brown pods one to two inches in diameter and two to six inches long, which split open when ripe and liberate numerous maple-like seeds.

Mahogany is the most valuable timber tree in tropical America and its wood is the standard with which other cabinet woods are compared. It is noted for its richness of coloring enhanced by time, for its deep glowing luster, for the rare beauty of its grain and luxury of figure and mottling. The lumber seasons readily without serious shrinkage, checking, or warping, is highly inert to atmospheric changes, is very durable, finishes smoothly, and is adapted for uses in solid form or veneers. It is the timber *de luxe* for cabinets, furniture, and interior trim and is prized by shipbuilders, while in the region of its growth it serves all sorts of purposes in carpentry, joinery, and general construction.

Mahogany timber exhibits a considerable range of variation in its physical and mechanical properties, depending upon the character of the soil and general conditions of growth as well as upon the species. The difference between woods from various regions is often so marked that experts can distinguish them almost at a glance and the kinds of mahogany on the market are designated according to country producing them and sometimes with reference to the port of shipment. The original Spanish mahogany of the West Indies may be considered the standard for the group and is the kind that was used almost exclusively in furniture such as is known as "antiques in mahogany" because it was most accessible to British shipping during the seventeenth and eighteenth centuries. It is hard and heavy, very richly colored, and often highly figured, and for certain classes of furniture is still unexcelled, though now difficult to obtain in large sizes. That from Santo Domingo is considered the finest.

All of the mahogany of the West Indies is the product of a single species, *Swietenia Mahagoni* L.; that from Mexico and Central America may be a mixture of two or three species, but is largely the product of the large-leaved kind, *S. macrophylla* King. This timber averages considerably lighter in weight than the West Indian, and trees of rapid growth in the lowlands yield wood, commonly called baywood, that is comparatively soft, straight-grained, and often lacking in figure, though better adapted for certain classes of work than the harder, cross-grained material. In fact, the variation in the quality of the mahogany serves to increase its range of usefulness.

SOURCES OF SUPPLY

Florida. Mahogany was formerly fairly common on some of the Keys and near the shore of the mainland of extreme southern Florida, but is now nearly exterminated except in the region of Cape Sable. The trees, which are rarely 50 feet in height and two feet in diameter, yield the hardest and heaviest timber of the genus, but are too few and scattered to be of commercial importance.

Bahamas. The trees were formerly abundant and of large size and furnished an excellent quality of timber highly esteemed by the trade. The available supply remaining is very small.

Cuba. Cuba has long been an important source of mahogany. Different kinds are recognized in the trade, that from Santiago, known in the trade as San Jago mahogany, being the hardest and of the darkest color. The wood is usually not so highly figured as that from Santo Domingo, but sometimes shows the peculiar dark oval markings, the so-called "plum-pudding" mottle. Cuban mahogany is considered especially well suited for chair frames on account of its strength.

Most of the timber is shipped from the southern ports and the amounts are subject to great fluctuations. During the years 1911 to 1915, inclusive, the exports to the United States varied from nearly three million board feet in 1911 to nearly five and a half million in 1913, dropping down to little more than a million and a half in 1915. The supply of Cuban mahogany has been so seriously depleted that the industry can never regain its former importance.

Island of Haiti. The mahogany from this source was the first exploited and has always been considered of highest quality for fine furniture. For 50 years prior to 1890 the average annual exports amounted to about two million board feet, reaching a maximum of eight million feet in 1844. During recent years shipments have been rather light and the logs rather small, though otherwise of good quality. It is estimated that there are about 75,000,000 feet of merchantable standing timber remaining, of which about 85 per cent occurs in the Dominican Republic.

Jamaica. Jamaica was at one time a great exporter of mahogany, principally to England, more than 500,000 board feet a year being shipped as early as 1753. The drain was so heavy that before the end of the eighteenth century mahogany was being imported from Central America to meet the European demand. The timber is of good quality, being much like that from Cuba.

Mexico. Mexican mahogany was first exploited by Europeans and

for a number of years the bulk of this timber consumed in the United States was bought in Liverpool, London, and Hamburg. About 1885, however, American firms secured concessions in parts of Tabasco where mahogany was most readily accessible on account of the long rivers draining into the Gulf of Mexico, and the use of the wood materially increased in the United States.

Two general kinds of timber are recognized, namely, the comparatively softer and lighter baywood, *Swietenia macrophylla*, of the lowlands in Campeche, Tabasco, Chiapas, and southward, and a harder, heavier, and darker-colored wood sometimes called black or ground mahogany, *S. humilis*, that is more like the Spanish mahogany of the West Indies; it grows at higher elevations and shipments usually emanate from the ports of Tuxpam and Tampico or from the interior of the Isthmus of Tehuantepec or from the west coast. Logs shipped from Tuxpam are generally referred to in the market as Cazones mahogany. The baywood is one of the largest trees of the forest and the immense boles are sometimes clear of branches for 60 or 70 feet.

The woods operations are usually of a very primitive nature and are highly expensive, largely because of the rough country and the scattered occurrence of the timber. The initial step is the "spotting" of the trees from some high vantage point. This is done usually in midsummer when the crowns of the mahogany show as yellowish-red in a sea of green. The trees are cut above the buttresses, the workmen standing on a platform built around the base, some eight or 10 feet high. The logs are generally hewn square and hauled out to the rivers on ox-carts, the wheels of which are cut from sections of tree trunks. When the streams are in flood, the logs are floated to shipping ports, sorted as to ownership, and made into rafts which are towed alongside the vessels for loading. In rough weather there is danger of the rafts being broken up and the logs carried out to sea.

Mexico is the largest producer of mahogany, the annual output being about 12 million board feet, of which about seven million feet, largely from Campeche and Tabasco, are shipped to the United States. Not all of this timber, however, is of Mexican origin, since considerable quantities are cut in the Province of Peten, Guatemala, and sent down the Usumacinta River into Tabasco. It is roughly estimated that there are six billion feet of standing mahogany timber in Mexico scattered over 30 million acres in the States of Quintana Roo, Yucatan, Campeche, Tabasco, Chiapa, Vera Cruz, Oaxaca, Guerrero, Jolisco, and Tepic.

British Honduras. Mahogany is one of the principal commercial timbers of this British colony and has been known to the trade for nearly

three centuries. The amount produced varies considerably from year to year, but has been steadily increasing. Much of the timber exported from British Honduras originates in Mexico and Guatemala.

The methods of logging are much the same as in Mexico, though north of Belize a narrow-gauge railroad is used in hauling the timber to the landing. Formerly all logs were squared in the forest in order to show the figure of the wood as well as to get rid of the sapwood and reduce the weight, but this method has proved too wasteful, particularly in the case of butt logs.

Guatemala. Fully 90 per cent of the mahogany of Guatemala is found within 25 miles of the coast, and the trees are scattered so that they do not average more than one to every five acres. The logs are hewn square and hauled on ox-carts to shipping points along the Occidente Railway and along the division of the International Railways of Central America extending from Guatemala City to San José. The construction of additional railways and the completion of the Chiquimulilla Canal would give impetus and encouragement to the mahogany industry of the west coast. There are many rivers, nearly all of which are navigable only for short distances for rafting purposes, including the Michitoya, Guacalate, La Gomera, El Naranjo, Coyolate, and several others, which are not utilized at this time for the reason that San José and Champerico are the only licensed ports for the Pacific coast. A number of mills sawing chiefly mahogany and cedar are operating there; the lumber is exported via San José and Champerico, while shipments are made also to Guatemala City. Much of the Guatemala mahogany reaches foreign markets through Mexico and British Honduras.

Honduras. Mahogany is of general occurrence throughout the northern half of the Republic and attains its best development along the rivers draining the lower northern slopes of the Continental Divide. Near the coast and in the virgin forests are extensive areas containing, on an average, two large mahogany trees to the acre, while farther inland, bordering the open pine and grassland, the trees become more scattered and are generally smaller, though the wood is said to be of superior quality. Excellent timber also occurs along the Sulaco River, a tributary of the Ulua, but it is not accessible.

The chief features that have hindered the more rapid depletion of the mahogany in Honduras are lack of transportation, the dense character of the forests, and the difficulty of moving the large logs to the rivers in a country where the soil is wet the year round. Thus far only the large trees near the streams have been taken out, and expensive roadways will have to be constructed before further operations can be under-

taken. The country was at one time famous as a source of mahogany, when the cutters in Belize came to the coast over 200 years ago and operated on a considerable scale along the Ulua River and its tributaries and on the Aguan, Negro, and Patuca Rivers, but shipments have been very small in recent years.

Nicaragua. The Atlantic coastal plain has been the scene of mahogany operations for many years and sawmills are located at Gracias and Bluefields. It is estimated that there are at least 100 million board feet of mahogany timber still available on the east coast of Nicaragua, about a fourth of which is now readily accessible. There is little timber available on the west coast and lumber produced is consumed locally, though formerly small lots were exported from Corinto and San Juan del Sur.

Costa Rica. Mahogany occurs sparingly along the watercourses on the west coast and along the San Juan River and its important tributaries in the northeastern part of the Republic. The timber is of good quality.

Panama. Mahogany grows chiefly on the Pacific slope and in the upper reaches of the Chagres and Sicsola Rivers in the west and has been reported also in the region bordering the tributaries of the Bayano and Tuira. It is nowhere abundant and the regions are hardly accessible and sparsely inhabited, so that the timber is not likely to be exploited for many years. A limited amount of timber is exported, and while the logs are large and well formed, the wood is not considered by some users to be equal in quality to that from Mexico and does not command as high a price.

Colombia. True mahogany, said to have been in former times fairly abundant in the coastal region, is now very scarce and only occasional individuals are found widely scattered over the areas where it was once common. It still enters the market in small amount, but has practically ceased to be of commercial importance. The Colombian mahogany of the trade is *Cariniana pyriformis* Miers.

Venezuela. Mahogany is available in considerable quantities throughout the accessible forests of the north and is said to exist in large quantities in Maturin, Guayana, and the large forests at the foot of the Andes. The wood is somewhat harder and darker than the Mexican variety and if it could be obtained in larger logs than what have been produced for export in the past it would bring very satisfactory prices in the foreign markets.

Photo by Panama American Timber Corp.

Mahogany Tree Ten Feet in Diameter.

(*Swietenia macrophylla.*)

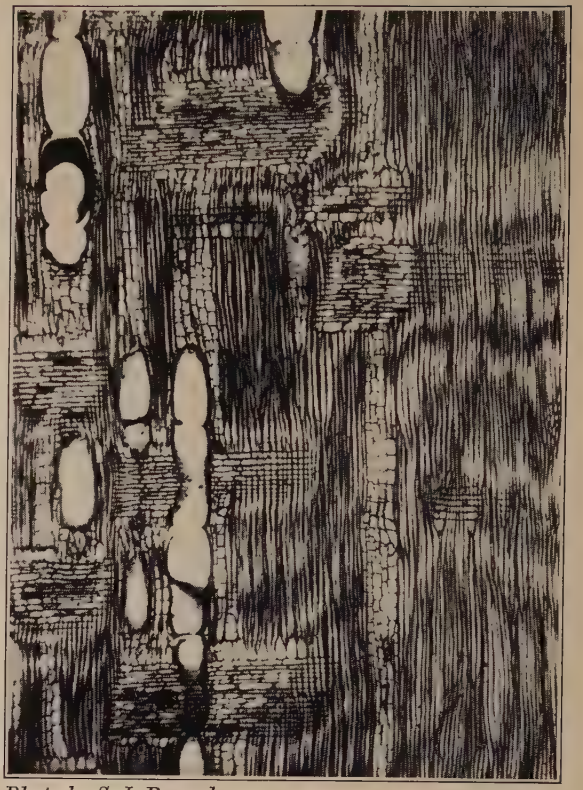


Photo by S. J. Record.

Radial Section of Venezuelan Mahogany (x 50).

(*Swietenia Candollei.*)

THE WOOD

Swietenia spp. *Mahogany.*

Common names: Mahogany, Spanish mahogany, Cuban, St. Jago, Santo Domingo, Honduras, Tobasco, Nicaragua, Mexican, etc., mahogany (Eng., trade); caoba (Span.); acajou (Fr.); mahoganiholz, acajouholz, echtes mahogani (Germ.); mogano, acagiu (Ital.); mogno, acajú, anacardo da America (Port.); mahok (Dutch); caoba monde, cedro carmesi, magnolia ? (Col.); caoba blanca, cedro cebello (Pan.); yulu (Nic.); caoba, cobano, flor de venadillo, gateado, palo zopilote, rosadillo, tzopilotl, venadillo, zopilote, z. colorado, z. negro, zopilotl, zopilocuahuitl, zopilo-zontecomacuahuitl (buzzard-head tree) (Mex.); madeira, madeira wood (Fla., Bah.); cedar, cedrela, redwood (old names).

General properties: Color widely variable from deep rich red to reddish-brown, pinkish or even yellowish; freshly sawn lumber turns red on surface when exposed to the sun; luster usually high, satiny. Sapwood pale yellow or nearly colorless; thin in old trees.

Odor and taste absent or not distinctive.

Variable from light and soft to hard and heavy. Sp. gr. (oven-dry) 0.38 to 0.84. Weight 24 to 52 lbs. per cu. ft. Feather or ribbon grain characteristic; some material very highly figured. Texture fine to rather coarse. Wood works readily, takes a beautiful polish, holds its shape, has exceptional cabinet qualities; durable.

Growth rings: Present, due to concentric lines or bands of parenchyma. No tendency to ring-porous structure.

Parenchyma: Inconspicuously about pores and pore groups and in very distinct, usually single, concentric lines or bands, mostly widely spaced, but sometimes crowded; visible on all sections, usually appearing of lighter color than background.

Pores: Rather large to very small; readily visible; occurring singly or more often in radial groups of two to several pores each; numerous, but not crowded. Mostly open, though some specimens show white contents conspicuously.

Vessel lines: Numerous, fine to medium, distinct; those with contents very distinct.

Vessel contents: Dark gum deposits common, sometimes nearly filling vessels for considerable length, again as localized specks. White deposits characteristic of West Indian and Venezuelan mahogany, showing very prominently on all sections.

Rays: Fine; variable in distinctness in different specimens from readily to scarcely visible on cross and tangential sections; distinct and may be conspicuous on radial, where they add materially to the figure of quarter-sawn lumber, usually appearing lighter than background.

Ripple marks: Present or absent; when present may be uniform or irregular; visible without lens; number per inch, 45 to 55.

Gum ducts: Occasionally present in compact peripheral row and filled with

dark red deposit; very distinct on longitudinal sections, particularly the tangential.

Minute anatomy: Very similar to that of *Cedrela.* For structure of wood of *Swietenia Mahagoni* see C. D. Mell: *True mahogany,* Bul. No. 474, U. S. Dept. Agr., Washington, D. C., 1917. For structure of *S. Candollei* see S. J. Record: The wood of the Venezuelan mahogany, *Bol. Com. e Ind.* No. 18, Caracas, Venez., 1921, pp. 582-593.

Material: Yale Nos. 831, 2154, 5986 (Cuba); 2155, 5045, 5046, 5932 (S. D.); 4121, 4122 (Barb.); 2738, 2745, 2746, 2748* (Curaçao); 4118, 4765, 5894 (Mex.); 29, 46, 69, 109, 133, 157, 165, 185, 229, 235, 236, 237, 249, 251, 268, 276, 278, 293, 294, 6631 (Hond.); 3725*, 3694* (Guat.); 5240 (Nic.); 6103 (C. R.); 5886 (Pan.); 4105, 4106 (C. A.); 413*, 427, 501, 502 (Col.); 330, 350, 363, 473, 2656, 2659, 4413, 4414, 4428*, 6662, 6663 (Venez.). Asterisk indicates botanical material.

CARAPA

There are about a dozen species of *Carapa,* mostly in western Africa. Of the two or three tropical American species the best known is *Carapa guianensis* Aubl. of the equatorial evergreen hardwood forests of South America and the Gold Coast of Africa. It is commonly known as crabwood in British Guiana and as "andiroba" in Brazil, but the timber is usually sold in the United States as British Guiana, Demerara, or Brazilian mahogany.

The tree is of limited occurrence on the overflow delta lands of the Orinoco in Venezuela, is very common in the Amazon flood plains and in the Guianas, often growing in nearly pure stands. At its best it is said to attain a height of 170 feet and a diameter of six feet, and is often 120 feet high and three feet through. It has enormous pinnately compound leaves with numerous large, leathery, opposite leaflets; the flowers are clustered, the fruit is a dehiscent globular capsule about the size of an orange, containing several smooth, pale brown, angular seeds as large as a horse-chestnut. These seeds are the source of an oil used industrially for making soap and for illuminating purposes; the natives anoint themselves with it to ward off mosquitoes. The bark is employed to some extent in tanning and contains an alkaloid, called carapina, of some medicinal application.

The timber is very popular in British Guiana and is used there for furniture, house construction, particularly for sills and for shingles, shipbuilding, including masts and spars, and for mills, mortar beds, and fencing. Two varieties are recognized, namely red crabwood, considered the best and supposed to come from trees growing in the uplands, and white crabwood, a timber of paler color and lighter weight, presumably from the lowlands.

Past attempts to establish a market for this timber in the United States have been unsuccessful, probably because the dealers have always tried to dispose of it as true mahogany. Limited quantities from Brazil are now entering the trade under the name of "andiroba" and it is believed that a substantial business can be built up, provided the cost can be kept low enough to compete with birch (*Betula*) in the manufacture of part-mahogany furniture. The wood has good cabinet qualities, glues readily, holds its place, and is tough and strong for its weight. It is suitable for interior trim, medium-priced furniture, and plywood. It lacks the richness of luster and figure of true mahogany, but is well suited for table legs, drawers, and similar purposes in association with mahogany.

THE WOOD

Carapa guianensis Aubl. *Crabwood; Andiroba.*

Common names: Crabwood, andiroba, British Guiana, Demerara, and Brazilian mahogany (Trade); crabwood, white crabwood, lowland crabwood, highland crabwood, caraba, white caraba, karaba, karapa, British Guiana mahogany (B. G.); crappa, crapa, krappa, crappo, karapa, krapaboom (Sur.); carapa, carapa jaune, carapa rouge, carapa blanc, crapo, andiroba carapa, bois caille (Fr. G.); bois rouge carapat (Guad.); andiroba, andiroba branca, andiroba-saruba, andirova, angiroba, nandiroba, nandirova, yandiroba (Braz.); caoba (C. R.); osuabise, osokoru, asoroa (Gold Coast, Africa); crabbaum (Germ.); batteo ? (Pan.).

General properties: Color uniform reddish-brown, often dark and dull; some specimens lustrous. Sapwood oatmeal color, not always sharply defined.

Odor and taste absent or not distinctive.

Rather hard and compact, though variable. Sp. gr. (air-dry) 0.60 to 0.75. Weight 37 to 47 lbs. per cu. ft. Grain mostly straight. Texture uniform; rather coarse. Wood works readily, finishes smoothly, takes paint and glue well; is durable.

Growth rings: Usually distinguishable on account of fine lines of terminal parenchyma.

Parenchyma: Usually visible, but not always distinct; in fine or rather fine concentric lines of variable spacing, but usually wide enough apart to appear as limiting growth rings; dark-colored; not distinct on longitudinal surfaces.

Pores: Rather large; numerous, but not crowded; fairly well distributed; solitary or more often subdivided radially two or three times; mostly open.

Vessel lines: Appearing as numerous coarse scratches; mostly long and straight.

Vessel contents: Dark gum deposits abundant; inconspicuous.

Rays: Very fine; visible, but not always distinct, on cross and tangential sections; conspicuous on radial, being considerably darker than background, producing distinct silver grain. In a specimen (Yale No. 4161) from Surinam, the rays are considerably broader and more distinct than in the others.

Ripple marks: Absent. A slight tendency noted in one specimen (Yale No. 3921).

Gum ducts: The occurrence of small gum ducts in a compact peripheral row, resulting from injury, has been noted; not conspicuous on account of dark color of wood.

Minute anatomy: Vessels with minute pits, the mouths slit-like and coalescing. Rays decidedly heterogeneous; mostly coarse-celled; gummy; one to five cells wide, few to 50 cells high, with considerable variation in size and shape in different specimens; pits into vessels very small, half-bordered, the ray side elongated to include few to several in vessel. Fibers often septate; variable in different specimens; pits minute, indistinct.

Material: Yale Nos. 3036, 4220, 5110 (B. G.); 4161, 4202, 5882 (Sur.); 368 (Trin.); 2114, 3359, 3921, 3926 (Braz.).

CABRALEA

This genus, consisting of nearly 40 species of trees and shrubs, is confined to tropical America and is most abundant and of chief importance in southern Brazil and northern Argentina.

The "cangerana" of Brazil, commonly referred to *Cabralea Congerana* Sald., is said to be a large tree, with a trunk 30 to 50 feet long and three to four feet in diameter. The pinnate leaves are large, with leathery leaflets that are pubescent on the under side. The flowers are borne in numerous axillary panicles and the fruits are dehiscent capsules about the size of small marbles. The bark, especially that of the roots, is used medicinally as a febrifuge. The dark red wood is highly durable and is used for general construction, carpentry, railway crossties, bridges, and fence posts. The specific gravity of the wood is said to vary from 0.66 to 0.82.

The "cancharana" of Argentina is referred to *C. multijuga* C. DC., but the name probably embraces a number of other species. It is a tree of medium height, but large diameter, with a dark brown, shallow-grooved bark 0.4 to one inch thick. The sapwood is a light flesh color, the heart dark red. According to Castro,[136] the wood has a specific gravity of 0.63 to 0.68, and resembles cedar (*Cedrela*) in color and fragrance, but is denser and harder and at the same time is less tough and elastic and more likely to split in nailing: on the other hand, it is more resistant to exposure than cedar and replaces it to advantage in some instances. It is used in furniture making, turnery, carpentry, wharf and dock construction, and shipbuilding. A red dye is extracted from the shavings and sawdust by soaking in water, and the bark is employed in tanning.

[136] Castro, Eduardo B.: *Las maderas Argentinas*, Rosario, 1918, pp. 231-232.

THE WOOD

Cabralea spp. *Cancharana.*

Common names: Cancharana, canchorono, canchorena, caxarana, cedro macho, cedro-rá (Arg.); cangerana, cangerana-mirim, canjarana, cajarana, conjerana-assú, cedro (Braz.).

General properties: Color dull red or maroon with a fine graining of parenchyma lines of lighter or darker shade, depending upon the lighting. Sapwood pinkish.

Without characteristic taste or odor when thoroughly dry. Said to be scented like *Cedrela* when fresh.

Not very heavy or hard. Sp. gr. (air-dry) about 0.65. Weight about 40 lbs. per cu. ft. Grain mostly straight, sometimes wavy. Texture medium to coarse. Wood easy to work, finishes smoothly, is strong, but brittle, and highly durable.

Growth rings: Apparently absent; concentric lines of parenchyma sometimes give appearance of very narrow growth rings.

Parenchyma: About pores and in numerous, rather closely spaced, finely wavy tangential or concentric lines or bands of rather open texture; bands vary in width from very fine to as wide as the pores; not prominent on cross section, but sometimes very distinct on longitudinal surfaces, producing an irregular pattern on the tangential.

Pores: Small to medium; not very abundant; readily visible; open; mostly in short radial groups of from two to several; no definite arrangement of pore groups, except as linked up in part by the parenchyma bands.

Vessel lines: Distinct, but not very conspicuous; mostly long and straight; coarse.

Vessel contents: Occasional gum deposits present.

Rays: Invisible without lens on cross and tangential sections; visible, but fine and inconspicuous, on radial, appearing darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations and small, crowded, bordered pits, the mouths often coalescing. Rays heterogeneous; one to three cells wide and few to 15 cells high; cells coarse, gummy; pits into vessels half-bordered, the portion in the ray cells often much elongated and covering several in the vessel. Fibers commonly septate; pits small, simple, indistinct.

Material: Yale Nos. 537, 1087, 1701, 1739, 4131, 4377 (Arg.).

GUAREA

This genus, with about 120 species of trees and shrubs, is widely distributed throughout tropical America; there are also a few important representatives in western Africa. Best known of the latter is *Guarea Thompsonii* Spr. & Hutch. of Nigeria, which according to Unwin,[137] is

[137] Unwin, A. N.: *West African forests and forestry,* London, 1920, p. 328.

a large tree with a white sapwood and a large core of light brown heartwood with a slight reddish tinge and a cedar fragrance when freshly cut. The timber is being exported along with that of another species and sold under the name of cedar mahogany or scented mahogany.

Little authentic information is available concerning the tropical American trees of this genus. The wood is of good quality and is used locally for many purposes, but is not exported. The species most widely distributed, apparently occurring throughout the whole of the American tropics, is *Guarea trichilioides* L. It was formerly an important source of timber in Porto Rico and highly prized by the natives for the manufacture of "strong wagons and carriages, farm implements, and general carpentry. The wood resembles mahogany and Spanish cedar and is useful for the same purposes. It is light reddish-brown, sometimes streaked with lighter and darker shades, hard, moderately heavy, strong, tough, and very durable in contact with the soil. It has an odor resembling musk."[138] The muskwood of Jamaica is *G. glabra* Vahl. Fawcett and Rendle[139] state: "All parts of this tree, especially the bark, have a strong smell of musk. The powdered bark is said to be a good emetic. The wood is red, soft, and splits easily."

Castro (*loc. cit.*, p. 313) says that the wood of the "camboatá blanca" of Argentina, *G. trichiliodes* L., is of a light reddish color with little distinction between heart and sap, and is used in the construction of carts and for tool handles, carpentry, and fuel. The fruit is edible and the bark is a tanning material.

The "marinheiro" or "macaqueiro" of southern Brazil, *Guarea* sp., is a large tree with pinnate leaves having 12 to 18 leaflets; the flowers are white and in dense panicles, and the fruit is a large four-celled capsule with two seeds in each cell. The wood is used in joinery and carpentry, particularly for the interior work of houses. The bark is used medicinally.

THE WOOD

Guarea spp. *Marinheiro.*

Common names: Marinheiro, macaqueiro, cedrão, taúva, taú, carropeta (Braz.). Other species: Muskwood, alligator wood, wild akee (B. W. I.); guaraguao, acajou (P. R.); yamao, gouare, yamagua ?, yamagua colorada ? (Cuba); bois bale, bois-balle, bois à balles, pistolet, bois pistolet (Fr. W. I.); redwood, bois rouge, cabimbo (Trin.); karaba-balli (B. G.); bailador, bilibili, guamo blanco, guamo cimarrón, mestigo, mestizo, tigre, trompillo (Col.); trompillo, trompito (Venez.); ataúba, bilreiro, café blanco, gito, jito, jatuaúba preta, peito de pomba (Braz.); camboatá, camboatá blanca, cedrillo, cedrillo

[138] Bul. No. 354, U. S. Dept. Agr., Washington, D. C., 1916, p. 78.

[139] Fawcett, Wm., and A. B. Rendle: *Flora of Jamaica*, London, 1920, p. 215.

blanco, guaimí-piré (Arg.); cedrillo, cedrillo cimarrón, guaraguao, trementino (Mex.).

General properties: Color of heartwood doubtful; possibly reddish or pinkish. Sapwood very pale brown or gray; not highly lustrous.

Odor and taste absent or not distinctive (at least in dry sapwood).

Of medium weight and density. Sp. gr. (air-dry) 0.58. Weight about 36 lbs. per cu. ft. Grain straight. Texture medium. Wood easy to work, finishes smoothly, is tough and strong, does not appear durable.

Growth rings: Absent or poorly defined; sometimes indicated by concentric zones deficient in parenchyma.

Parenchyma: Abundantly developed; in rather large patches about the pores and often united into distinct wavy tangential lines or bands of variable length and width, suggesting elm (*Ulmus*); produces pattern on tangential surface.

Pores: Medium-sized; visible; not very numerous; fairly regularly distributed; occurring singly or subdivided two or more times; open; some have abundant parenchyma about them, others very little.

Vessel lines: Distinct on account of parenchyma, appearing darker than background; long and straight.

Vessel contents: Some gum deposits.

Rays: Very fine; not visible without lens on cross and tangential sections; fine and inconspicuous on radial surface, appearing of same color as background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits very small, the mouths slit-like, extending beyond the borders, and coalescing to resemble spiral striations. Rays mostly homogeneous; some heterogeneous; one to three, mostly two, cells wide and few to 35 cells high; cells rather large; pits into vessels half-bordered as in *Cabralea*. Fibers septate in part; non-septate fibers have slit-like mouths and small circular borders.

Remarks: In none of the five specimens of the wood of this genus available is there any sign of heartwood, three of them being from small stems. The woods of all of them have a very similar structure. The arrangement of parenchyma and pores suggests certain of the Leguminosae.

Material: Yale No. 3169 (Braz.). Other species: Yale Nos. 1020 (Arg.); 2718 (P. R.); 2982 (Pan.); 4856 (Haiti); 6664 (Venez.).

TRICHILIA

There are over 200 known species of *Trichilia*, but they are mostly small trees and shrubs, widely distributed throughout tropical America; a few occur in western Africa and Madagascar. The woods are hard and heavy to only moderately so, fine-textured, stiff and strong, but not durable; they serve locally for many purposes for which we use hickory (*Carya*) and ash (*Fraxinus*).

The best known of the Argentine trees of this genus is the "catiguá," commonly referred to *Trichilia Catigua* A. Juss., though probably representing several species. The tree is not over 50 feet high and 18 to 24 inches in diameter. The flesh-colored wood is said to be rather hard and heavy, specific gravity 0.60 to 0.72, strong, tough, easy to work, and used for wheels and shafts of vehicles, and for carpentry and general construction. The bark is employed in tanning and dyeing.

The largest known representative of this genus is the Brazilian "pimenteira" or "páo rosa branca," *Trichilia alta* Blake. Mr. Curran, who was the first to collect it, says: "This is a common tree of the Bahia coast forest where it grows in association with 'jequitibá' (*Cariniana*), 'páo d'alho' (*Gallesia*), 'araçá de agua' (*Terminalia*), etc. It occurs singly or in small groups, never in pure stands. Heights of 125 feet and diameters up to three feet are common, while the clear lengths are usually 40 to 50 feet. The trunks are of good timber form and have a thin black or slate-gray bark. The wood is not durable in contact with the ground and is little used, being probably unknown in the local markets. Tests made in the United States prove that it machines well, does not warp or check badly, and has good possibilities for flooring and as a substitute for hickory." Tests on the mechanical properties made at the University of Michigan gave the following results: Specific gravity (oven-dry), 0.711; weight (8.61 per cent moisture), 48.7 lbs. per cu. ft. Crushing strength parallel to grain, 7770 lbs. per sq. in. Bending: Modulus of elasticity, 1,840,750 lbs. per sq. in.; fiber stress at elastic limit, 11,990 lbs. per sq. in.[140]

THE WOOD

Trichilia alta Blake — *Pimenteira.*

Common names: Pimenteira, páo rosa branca (Braz.). Other species: Muskwood (Jam.); cabo de hacha, caracolillo, gaita, guaita, guayavacón, jobillo, molinillo, palo de anastasio, ramoncillo, retamo (P. R.); cabo de hacha, guabán, jubabán, siguaraya (Cuba); bagre, manglé blanco, manglesito, yayo, yayo colorado (Col.); cedrillo (Venez.); catiguá, catiguá graúdo, catiguá miúdo (Braz.); catiguá, catiguá blanco, catiguá colorado, catiguá puíta, fe do gozo, guamirí, mangacitara, palo anis, tapé-riguá (Arg.); uruca (C. R.); matapiojo (Nic.); barredero, barrehorno, canellillo, canjuro, cedrillo, cola de pavo, jocotillo, ojo de muñeca, pimientillo (Salv.); cabo de hacha, cauache, choben-ché, cucharillo, estribillo, garbancillo, garrapatillo, limoncillo, xkulinsis (Mex.).

General properties: Color light reddish-brown. Sapwood, which composes the bulk of even the largest trees, is nearly white or slightly roseate when freshly cut, becoming pale brown.

[140] Babbitt, Will C.: Turnings from Brazilian hardwoods, *Wood Turning* (Milwaukee), 16:7:17, Apr., 1923.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.72. Weight about 45 lbs. per cu. ft. Grain straight. Texture rather fine. Wood fairly easy to work, finishes smoothly, takes a high polish, turns moderately well except on cross-grain cuts, is tough and strong, does not warp or check badly, is not durable in the ground. Resembles birch (*Betula*).

Growth rings: Absent or very poorly defined.

Parenchyma: In numerous, rather fine, wavy, continuous or much broken tangential or concentric lines in contact with the edge of the pores or independent of them; visible, but not conspicuous; spacing very uneven.

Pores: Small; faintly visible without lens; not very numerous; scattered fairly regularly; solitary or subdivided radially two or three times; open.

Vessel lines: Fine; fairly distinct; darker than background.

Vessel contents: None observed.

Rays: Not visible without lens on cross and tangential sections; distinct, but low and not conspicuous, on radial surface, being darker than background, suggesting birch.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits very small and crowded, with lenticular mouths. Rays more or less heterogeneous; uniseriate or occasionally biseriate in part, few to 30 cells high; cells large, gummy; pits into vessels small, half-bordered. Fibers slender, thick-walled; pits numerous, with slit-like apertures extending beyond the small round borders.

Remarks: The wood of the Colombian "bagre," *Trichilia triphylla* Blake (Yale No. 1527*; Curran's No. 299), is white and considerably less dense than that of *T. alta.* The structural features are much the same, except that the growth rings are rather distinctly marked by terminal parenchyma lines. *T. pallida* Schwartz of Haiti (Yale No. 4819) is intermediate of these two.

Material: Yale No. 3945* (Curran's No. 56; type tree), 1926, 4679* (Braz.). Asterisk indicates botanical material.

34. MALPIGHIACEAE

This family, consisting of about 60 genera and over 600 species, is widely distributed throughout the tropical and sub-tropical regions of the world. It is of comparatively little economic importance, most of the species being woody vines, shrubs, or only small trees. The bark, which is usually rich in tannin, is of more or less commercial value in the tanning and dyeing industries, and also serves medicinally as an astringent and febrifuge. The only genus worthy of consideration is *Byrsonima.*

BYRSONIMA

This genus, with over 150 species, is of some local value for its timber, though the trees are small and many species are mere shrubs. Their

distribution includes the whole of tropical and sub-tropical America, where they occur along the borders of swamps and as a part of the understory of the high forest in both upland and lowland. The bark is of more importance than the wood.

Byrsonima spicata Rich. is a fairly common tree in parts of the West Indies and in the Guianas. It rarely attains a height of 60 feet and a diameter of 24 inches, and the rather fine-textured wood, which is rather hard and strong and of a dull brown or reddish color, is used to some extent for furniture, general carpentry, the frames of buildings, and also for fuel and charcoal. There are other West Indian species which are said to produce beautiful lustrous reddish wood of fine texture, and highly esteemed for cabinetmaking, turnery, and fancy flooring. The common name is "doncella," but wood which has been sold in the New York market under this name appears to belong to the *Sapotaceae*. The wood specimens of *Byrsonima* in the Yale collection from the West Indies are coarse-textured and of the dull reddish color of raw beef. The distinct deep-colored rays and the fine roe grain combine to give a handsome appearance to a finished surface.

Byrsonima crassifolia H. B. K. is a small or middle-sized, usually low-branched tree, occurring in the savanna formation and semi-arid districts of southern Mexico, eastern Central America, and through northern South America to portions of the West Indies. A decoction of the bark is reputed to be effective against certain cutaneous diseases and in Panama a beverage known as "chica" is made by fermenting the fruits. The wood is used to a small extent for small construction timbers and for fuel and charcoal.

THE WOOD

Byrsonima crassifolia H. B. K. *Golden Spoon.*

Common names: Golden spoon (B. W. I.); nance (C. A., Mex.); nance colorado, nance blanco (Pan.); nance verde, nancite (Salv.); changugo, chi, nananche, nanche, n. agrio, n. de perro, nanchi, nantzinxocotl, nanzinquahuitl (Mex.); chaparro (Venez.); peralejo (Col.). Other species: Murecy, mureci, murici, moro-cy, murecy vermelho, murci, mureila, pecegueiro bravo, páo de cortume (Braz.); yaca, yuco, nance (Col.); chaparro manteca (Venez.); bois tan, bois de tani, bois dysentérique, merisier doré, itchia, surette, mauricif, mourresif (Fr. G.); bois canne, mauricie, moureiller (Guad.); surette de grands bois, ceresa del monte, mureche (Trin.); hitchia (B. G.); maricao, palo de doncella, sangre de doncella (P. R.); carne de doncella, sangre de doncella, peralejo del monte, peralejo macho (Cuba); locust berry, guana berry, candle berry, pigeon berry (B. W. I.).

General properties: Color dull reddish or pinkish-brown. Sapwood lighter, not clearly defined.

Odor and taste absent or not distinctive.

Wood rather hard and heavy, strong, brittle. Grain more or less roey. Texture rather coarse. Wood fairly easy to cut, does not take a smooth natural finish; appears fairly durable.

Growth rings: Present; distinct to indistinct, due to variations in depth of color and sometimes also to relative abundance of pores.

Parenchyma: Not visible.

Pores: Small, but visible; fairly numerous, but not usually crowded; fairly well distributed; occurring singly or more often in radial groups of two or three, sometimes more.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Rather fine; indistinct; appear coarse, but not very sharply defined under lens on cross section; scarcely visible on tangential; low, but very distinct, on radial surface being of deeper color than background. Cells large enough to show heterogeneous structure of ray under simple lens.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations. Rays heterogeneous; one to three cells wide and few to 60 cells high; cells coarse; pits into vessels very numerous, half-bordered; of same size and shape as inter-vascular pits. Wood parenchyma sparingly developed; diffuse. Wood fibers with simple pits; sometimes septate.

Remarks: Structure agrees closely with specimen (Yale No. 2706) from Porto Rico, supposed to be *B. spicata* Rich.

Material: Yale Nos. 3000 and 3022, collected by Dr. Pittier in Panama; his Nos. 4685 and 4499, respectively.

35. VOCHYSIACEAE

This family is confined to tropical America and consists of five genera and nearly 150 species of trees, shrubs, and a few herbaceous plants, with their center of distribution in Brazil. The woods as a whole are light and soft, tenacious and strong for their weight, easy to work, and suitable for many of the purposes to which the softer grades of non-durable conifers are now employed. The fact that the trees grow very rapidly and are of good timber form gives them a special interest from the forester's standpoint. In structure the woods suggest the Leguminosae in that they have abundant paratracheal and metatracheal parenchyma, vessel perforations that are exclusively simple, and membranes of the bordered pits usually showing a sieve-like structure.

Huber[141] says that in the Amazon region there are many arborescent species of the genera *Vochysia*, *Qualea*, and *Erisma*, and that some of them are among the most conspicuous trees of the uplands and the banks

141 Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:188 (1909).

of the fresh-water streams, partly on account of their large size and also because during the blossoming season they are transformed into veritable bouquets of yellow (*Vochysia*), white or rose (*Qualea*), and purple (*Erisma*). The soft, light-colored woods are not highly resistant to decay and accordingly are not extensively used in that humid climate.

Salvertia, with only one known species, is a small tree of the lower Amazon. *Callisthene* has nine or ten known species in Brazil, Bolivia, and neighboring regions. The "itapiúna" of Minaes Geraes, *C. major* Mart., supplies some material for general carpentry and also for fuel and charcoal. There are about 10 species of *Erisma* in Brazil and the Guianas, but little information is available concerning them. A specimen (Yale No. 4050, from Pará) believed to be of this genus, has comparatively few rather large pores, and numerous wavy bands of parenchyma. It is of about the consistency of *Cedrela* and the color is a deep reddish-brown, indicating a higher degree of durability than is generally credited to this family. The names applied to this tree in the Amazon region are "quaruba" and "cachimbo de jaboty."

QUALEA

There are over 40 species of this genus, mostly in Brazil, where they are variously known as "páo terra," "laba-laba," "umirirana," "muiraúba da varzea," and "muiraúba da terra firme." Some of the woods are used locally for canoes, sheathing, boxes, and interior construction. The bark and fruits are credited with medicinal properties and also yield dyestuffs. According to Bertin,[142] the "cèdre gris" of French Guiana *Qualea rosea* Aubl., is of good timber form and attains a height of 100 feet with a trunk diameter of from two feet on the average up to a maximum of nearly five feet. In the areas examined, this species ranked eighth in abundance, comprising a little less than 2 per cent of the total. The heartwood has a specific gravity of 0.648, is rather soft, but compact, easy to work, holds its shape, and is fairly durable. The local uses include flooring, general carpentry, and lumber for miscellaneous purposes; suggested uses are all kinds of light carpentry, joinery, interior construction, and bodies of vehicles.

VOCHYSIA

There are about 80 species of this genus, ranging from tall forest trees to shrubs and perennial herbs, confined almost exclusively to tropical South America. The woods of the Brazilian species are used to a

[142] Bertin, A.: Les bois de la Guyane française et du Brésil, *Miss. For. Col.*, V, Paris, 1920, pp. 81-82.

limited extent for canoes, carpentry, interior construction, and charcoal, and in the drier regions for fence posts. The sap of the "vinheiro do matto" of southeastern Brazil, *Vochysia tucanorum* Mart., is gathered by the natives and yields upon fermentation a kind of wine or beer. The "eta-balli" of British Guiana, *V. tetraphylla* DC., is said to be abundant in the lowlands near streams, where it attains an average of 90 feet with a bole 60 feet long and large enough to square 14 to 18 inches. The timber, which is little used, is light and soft, and the heartwood is of a uniform pinkish-brown to reddish-brown color with a golden luster, merging into the gray or yellowish sapwood.[143]

Vochysia guatemalensis J. D. Smith is a fairly common tree of large size in Central America, and during the blossoming season the vast panicles of shiny yellow flowers are very conspicuous. So far this is the only species of the genus and, with a single exception, the only representative of its family that has been found outside of South America. When the smoothish gray bark is cut, a colorless sap exudes which becomes gummy upon exposure to the air. The trees are of merchantable proportions, with long, clear boles often over two feet through. The lumber is used locally to a limited extent for general construction and miscellaneous carpentry.

THE WOOD

Vochysia guatemalensis J. D. Smith — *San Juan.*

Common names: San Juan, sanpadranno (Guat.-Hond.). Other species: Eta-balli, aeta-balli, ite-balli[144] (B. G.); cèdre gris (Fr. G.); quaruba, coariuba, páo terra, congonheiro, congonha do compo, rabo de tucano, rabo de arara, urucuca, cinzeiro, páo de cinza, páo doce, páo de tucano, fruta de tucano, vinheiro do matto, coxa de frango, caixêta, páo de vinho, páo de vinho preto (Braz.).

General properties: Color pinkish-brown with a golden luster; sapwood gray.

Odor and taste absent or not distinctive.

Light and soft, but firm. Sp. gr. (air-dry) 0.42. Weight about 26 lbs. per cu. ft. Grain somewhat coarsely roey. Texture coarse. Wood brittle, easy to cut, saws woolly when fresh, does not appear durable.

Growth rings: Absent or poorly defined; sometimes indicated by more orderly arrangement of elements.

Parenchyma: About the pores and in irregular, wavy tangential or concentric bands; very distinct on cross section and fairly so on longitudinal.

Pores: Rather large; readily visible; numerous, but not crowded; well distributed; mostly single, but sometimes in small groups.

143 For detailed description see Stone and Freeman: *The timbers of British Guiana,* London, 1914, pp. 26-27.

144 Not "eta-balli" or "ita-balli," according to Stone, *loc. cit.*

Vessel lines: Appearing as rather deep scratches; not conspicuous.

Vessel contents: Some tyloses present.

Rays: Rather coarse; very distinct on cross section; visible on tangential; producing fairly distinct silver grain on radial surface. Cells large enough to show heterogeneous structure on radial sections under hand lens.

Ripple marks: Absent.

Gum ducts: Vertical ducts of the gummosis type in single compact peripheral rows noted; larger than pores; mostly open; some dark gummy contents.

Minute anatomy: Vessel perforations simple; pits with sieve-like perforations in their membranes. Rays heterogeneous; of two kinds; (1) uniseriate and low; (2) three to six cells wide and varying in height up to 100 cells or more; pits into vessels rather large, variable in shape, half-bordered, open-mouthed, membranes dotted. Parenchyma abundant and coarse-celled. Wood fibers with simple pits; often septate.

Material: Yale Nos. 3681 and 3708 collected with leaves and flowers by Messrs. Whitford and Stadtmiller on Guatemala-Honduras boundary.

36. EUPHORBIACEAE

The Spurge Family, consisting of about 250 genera and upward of 5000 species of trees, shrubs, and herbs, having acrid and often poisonous juice, is widely distributed over the world, mainly in the tropics. It is chiefly important as a source of products other than wood. Species of *Hevea* yield the Pará rubber of commerce, while the Ceará rubber is the product of *Manihot Glaziovii* Muell. Arg. The cassava root and the tapioca are supplied by *Manihot utilissima* Pohl. Castor oil is obtained from the seeds of *Ricinus communis* L., croton oil from species of *Croton* and *Jatropha*, and Chinese wood oil or tung oil from the seeds of *Aleurites*. Several species are sources of dyes; others have juices, some caustic and highly poisonous, which are credited with medicinal virtues. The family is of comparatively little importance as a source of wood. The best known timber is the Turkish boxwood, *Buxus sempervirens* L.,[145] the only satisfactory wood for engraving purposes.

There are 57 woody genera in India, but according to Gamble[146] none of them produces first-class timber, "the best being probably *Bischofia javanica*, and only a few like *Bridelia retusa*, *Phyllanthus Emblica*, *Cleistanthus collinus*, and *Mallotus philippinensis* are sufficiently common to be of importance to Indian sylviculture. . . . Compared with others of a similar large number of species, Euphorbiaceae is certainly uninteresting in a forest point of view. It contains nothing near the

[145] Some botanists include this in another family, the Buxaceae. For description of the wood of *Buxus* see Record, S. J.: Boxwoods of commerce, *Bul. Torrey Bot. Club*, 48: 297-306, Jan. 19, 1922. There are species of *Buxus* in Mexico and Cuba.

[146] Gamble, J. S.: *A manual of Indian timbers*, London, 1902, p. 589.

number of useful timbers that is produced in its great neighbour, the Urticaceae."

The only large tree of this family of very wide distribution in the Philippines is the "tuai," *Bischofia javanica* Bl. Various species of *Cyclostemon* furnish lumber useful for all sorts of interior work, and *Aleurites* and *Cyclostemon* produce wood of good quality for match-sticks and match-box veneers. Of the tropical African trees, the best in the family is the African oak, *Oldfieldia africana* Hook., a very large and tall tree with a heavy, hard, and strong wood at one time exported as teak for use in the British navy.

There are at least 50 arborescent genera in tropical America, but, with very few exceptions, the trees are of small size, often only a little larger than shrubs. Huber[147] says that the family is exceptionally well represented in the Amazon region, but occupies a secondary place in the list of Amazon woods, because only a few species reach large dimensions, and these have a white wood considered of little value. The wood of the "seringueira branca," *Hevea brasiliensis* Muell. Arg., is very light, that of the "seringueira vermelha," *Hevea guyanensis* Aubl. and related species, a little heavier. The wood of *Sapium* aff. *lanceolatum* Hub., a small-leaved species in the vicinity of Belem, is light, fairly homogeneous, of a beautiful yellow color when varnished, and probably could be used to advantage in joinery. The "taquarizeiro," *Mabea* spp., has a yellow wood which is a little heavier; the new shoots of this tree are hollow and very slender, and are used to make pipe stems. The "piranheira," *Piranhea trifoliata* Baill., is a small tree with a very hard wood that is so durable in the water that the trunks in the beds of the rivers constitute a great menace to navigation.

The woods of this family exhibit a wide variety in their structure and in their properties. In general the pores are not very numerous and often tend to form radial rows. Parenchyma is not abundantly developed and is typically disposed in characteristically very fine, irregular, often very closely spaced tangential or concentric lines such as are commonly found in the order Malvales. The rays are mostly fine and inconspicuous and are not storied. Radial canals, often large and distinct, occur in specimens of *Croton* (Yale No. 2821*, Curaçao, and 3714*, Honduras), and *Alchornea* (Yale Nos. 1726*, Arg., and 3179, S. Paulo, Braz.). Similar structures exist in *Sapium baccatum* Roxb. (Yale No. 4966, Sumatra), *S. Merrillianum* P. & H. (Yale No. 2293, Phil.) and (of smaller size) in *Euphorbia Tirucalli* L. of Formosa.[148] The vessels, as a

147 Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 188-189 (1909).

148 See Kanehira, R.: *Anatomical characters and identification of Formosan woods*, Taihoku, 1921, p. 194 and pl. 37, fig. 219.

rule, have simple perforations; they are scalariform in *Buxus* and this feature is sufficient to separate the Turkish and East London boxwoods from the other boxwoods of commerce. The pits between vessels and parenchyma may be all half-bordered or with transitions to large and irregular simple pits. Thick-walled wood fibers are often provided with a gelatinous layer and frequently the thin-walled ones are septate.

The tropical American genera characterized by woods that are hard and heavy or moderately so are: *Chaetocarpus*, *Croton*,[149] *Drypetes*, *Gymnanthes*, *Hieronymia*, and *Phyllanthus*. Their timbers are used to some extent for heavy construction, and in the manufacture of furniture and special articles. The genera with light and soft woods are: *Alchornea*, *Alchorneopsis*, *Aporosella*, *Hevea*, *Hura*, *Jatropha*, *Joanesia*, *Mabea*, *Manihot*, *Ricinus*, *Sapium*, and *Sebastiana*. Their timbers are used or are suitable for general carpentry, sheathing, boxes, crating, matches, and paper pulp. The only one of this group that promises to become of much economic importance is *Hura*. An intermediate group includes *Aextoxicum*, *Hippomane*, and *Pera*, with woods suitable for carpentry, furniture, and general construction.

HIERONYMIA

Of the dozen or more species of this genus in tropical America, the best known and most widely distributed is *Hieronymia alchorneoides* Allem., which has a range extending from southern Brazil to western Panama. It is a large dioecious tree, sometimes 100 feet high and three feet in diameter; with a grayish, scaly bark; alternate, simple, leathery leaves; and small drupaceous fruits. The wood is of good quality and is used for general construction, cabinetwork, vehicle construction, and for service in damp and exposed situations, such as posts, ties, bridges, and boatbuilding.

THE WOOD

Hieronymia alchorneoides Allem. *Urucurana.*

Common names: Urucurana, u. mirim, u. de leite, urirana, arocurana (Braz.); suradanni, seridani, dalina (B. G.); tapana, tapanare (Trin.); pantano, zapatero (Pan.). Other species: Suradanni (B. G.); cajuela (Cuba); cedro macho (P. R.).

General properties: Color, a deep reddish-brown in old specimens; rather dull to fairly lustrous. Sapwood pinkish.

Odor and taste absent or not distinctive.

Rather hard and heavy. Sp. gr. (air-dry) 0.72. Weight about 45 lbs. per cu. ft. Grain irregular; more or less roey. Texture uneven; mostly coarse.

[149] The woods of some species of *Croton* are said to be light and soft.

Wood hard to cut and split; takes a smooth finish; inclined to warp badly; appears durable.

Growth rings: Sometimes clearly defined, due to layer much richer in pores in inner portion of ring.

Parenchyma: Scarcely visible even with lens; appearing as very fine scattered cells or in very short lines.

Pores: Of medium size, readily visible; very abundant in certain concentric layers which may be one-fourth inch in width; much less numerous elsewhere, where they are for the most part single.

Vessel lines: Distinct, but not conspicuous, except that layers of abundant pores are pronounced; lines alternating long and short (roe grain); scalariform perforations visible with good hand lens.

Vessel contents: Some dark gum deposits noted; also abundant white deposits in one specimen (Yale No. 4203).

Rays: Very fine, mostly invisible without lens on cross and tangential sections and not very distinct with it; readily visible, but inconspicuous, on radial surface, where they appear slightly darker than background; coarse-celled, the cells visible with lens.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with both simple and scalariform perforations; the latter with numerous heavy bars. Rays mostly uniseriate, some two- to four-seriate in middle portion; often very high; decidedly heterogeneous; cells thick-walled; gummy, abundantly pitted; pits into vessels few, very large, rounded or elongated and more or less scalariform. Fibers with numerous distinctly bordered pits. Structure resembles *Humiria* (Humiriaceae), but differs in size of vessel-ray pits and in width of rays.

Remarks: A specimen of wood supposed to be *Hieronymia laxiflora* Muell. Arg. (Yale No. 3048) is indistinguishable from this species, but has a sp. gr. of 0.85. Weight about 53 lbs. per cu. ft.

Material: Yale Nos. 2510, 3249 (Braz.); 4203, 4223 (B. G.).

HIPPOMANE

This genus consists of a single species, *Hippomane Mancinella* L., with a range extending from southern Florida through the West Indies, along northern South America, and through Central America into southern Mexico. Though usually of small dimensions, this tree sometimes attains a height of 65 feet and a diameter upward of three feet. It has rather large simple leaves, and the fruits, which resemble small apples, often remain on the branches until after the flowers appear the next season. The bark contains a thick milky juice that is very caustic and poisonous, producing eruptions when it comes in contact with the skin and seriously irritating or destroying the mucuous membrane if it is taken internally. There is a legend to the effect that those who sleep

in the shade of this tree do not awaken, and for this reason the tree is often called "arvore da morte" (Portuguese) and "arbol de la muerte" (Spanish). The usual Spanish name is "manzanillo," meaning "little apple."

The following is quoted from Fawcett and Rendle:[150] "Sloane states that large boards are sawn from the trunk of this tree, not only for wainscot and cabinets, but even for the largest tables, this wood being much coveted by all people for its polish, durability, and delicate and various colours. Brown adds, 'to guard against its corrosive juices, the wood cutters are obliged to make a fire round the body of every tree some time before they can venture to fell them; they burn the bark off, and so get rid of the acrid sap.'"

THE WOOD

Hippomane Mancinella L. *Manchineel.*

Common names: Manchineel (Fla., B. W. I.); manzanillo (Span., gen.); mancenille, mancenillier, manconilier (Fr., gen.); manzinellenbaum, manschinellapfel (Germ.); penipeniche, pinipiniche, manzanillo de la costa (Cuba); mançanila (Venez., Col.); manzanillo de la playa (C. R.); arbol de la muerte, hincha huevos (Mex.); mancenilheira, arvore da morte (Braz.); ficha (Peru).

General properties: Color a peculiar yellowish-brown variegated with brown and black, suggesting Circassian walnut; lustrous. Sapwood yellowish.

Said to have scent of lavender, but absent in present specimen. Taste not distinctive.

Of medium hardness and weight, suggesting walnut. Sp. gr. (air-dry) 0.68. Weight about 43 lbs. per cu. ft. Grain fairly straight to irregular. Texture fine and uniform. Wood easy to work; takes a high polish, does not warp or check badly; durable. An excellent cabinet wood.

Growth rings: Structurally absent or indistinct; darker zones may give local appearance of growth rings.

Parenchyma: In extremely fine, wavy, tangential or concentric lines, mostly independent of the pores; usually invisible without lens; produce fine and indistinct pattern on tangential surface.

Pores: Rather small, but readily visible; not very numerous; evenly distributed; occurring singly or as though subdivided two or three times.

Vessel lines: Fine, but distinct; darker than background.

Vessel contents: Gum deposits common; tyloses present.

Rays: Very fine and numerous; invisible on cross or tangential sections; visible, but fine and inconspicuous, on radial surface. Aggregates of gummy rays produce dark specks on tangential surface.

Ripple marks: Absent.

[150] Fawcett, Wm., and A. B. Rendle: *Flora of Jamaica*, vol. IV, London, 1920, pp. 328-329.

Gum ducts: None observed; small latex tubes, visible only under compound microscope, are present in some of the rays.

Minute anatomy: Vessels with simple perforations; pits with elongated and often coalescing apertures. Rays mostly uniseriate, low, homogeneous; very gummy; pits into vessels mostly half-bordered, round or elongated and of same size as other vascular pits. Wood fibers narrow, with small simple or indistinctly bordered pits. Calcium oxalate crystals common in rays and wood parenchyma.

Material: Yale No. 4120 from a piece of furniture collected by Mr. Curran in Curaçao.

GYMNANTHES

Of the several species of this tropical American genus the best known is *Gymnanthes lucida* Sw. (= *Excoecaria lucida* Sw. = *Sebastiana lucida* Muell. Arg.), which occurs in southern Florida, the Bahamas, and the Antilles. At best it is a small tree, rarely exceeding 30 feet in height and 10 inches in diameter, and frequently it is little more than a shrub. The leaves are simple and elongated, thin and red when young, later becoming lustrous green and leathery. The fruit is a small three-lobed capsule. The trunk is often irregularly ridged and has broad buttresses at the base. The hard, fine-textured, beautifully figured wood is used for small articles of turnery and carving. Occasional logs reach the New York market and veneers in the form of thin cross sections called Cuban oyster wood[151] are sometimes used in fancy cabinetwork.

In Cuba this tree is known as "aité" or "yaití." Neville[152] says: "There is a multitude of smaller hardwoods in Cuba of fine grain, capable of taking a brilliant polish, and of beautiful colors, which do not attain a size large enough to be utilized for general cabinet work, but which lend themselves for inlaying purposes and for the making of small articles, such as brush and mirror backs, etc. . . . 'Yaití' can be included among these small woods. This tree grows straight and slender, has a white sap, but a deep brown heart, the brown being interspersed with lighter shades, in some cases even with yellow." The tree occurs as one of the important elements of the under story of the mixed hardwood forests in the uplands and also in the better-drained lowlands. The wood is highly esteemed locally for poles, posts, stakes, and miscellaneous purposes requiring a small-sized timber of great strength and durability. It is used also for making canes and novelties.

151 The name "oyster wood" is applied to cross sections of the stems of various woods, principally the laburnum and yew, sometimes lignum-vitae and Judas-tree (*Cercis*), which were used as veneers in the Queene Anne period.

152 Neville, H. O.: Hardwoods in Cuba, *The Cuba Review,* 18: 1: 21, Dec., 1919.

THE WOOD

Gymnanthes lucida Sw. *Aité.*

Common names: Aité, haité, yaití, yaití macho, aceitillo (Cuba); yaití (P. R.); crabwood, poison wood (Fla.); crabwood (Jam.); granadilla (S. D.); bois vert (Guad.); Cuban oyster wood (trade, rare). OTHER SPECIES: Haïti vert, colas, ebène vert brune, casse haches (Mart.); bois vert, ebène vert (Guad.); branquilho (Braz.).

General properties: Color variegated olive-brown; irregular dark streaks and layers common. Thick sapwood white, sharply defined.

Odor and taste not distinctive.

Hard and heavy. Sp. gr. (oven-dry) 1.10 to 1.20. Weight 68 to 75 lbs. per cu. ft. Grain fairly straight to irregular. Texture very fine and uniform. Wood fairly easy to cut, takes high polish; durable.

Growth rings: Present, but indistinct; due to row of flattened fibers. Dark zones, with no definite relation to true growth rings, may show concentric arrangement.

Parenchyma: In fine, irregular tangential or concentric lines; visible in part; not very clearly defined even with lens; mostly independent of pores.

Pores: Very small, not visible without lens; numerous; not always evenly distributed; occurring singly or more commonly in radial rows of few to many pores each.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Very fine; numerous; invisible or nearly so on cross section; invisible on tangential; visible, but low and inconspicuous, on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels thick-walled; segments of very unequal length, often overlapping, with simple perforations; pits rounded with lenticular orifice. Rays uniseriate, few to 45 cells high; decidedly heterogeneous; cells abundantly pitted; pits into vessels half-bordered and of same size and shape as the ordinary vascular pits; crystals abundant. Wood fibers slender; often with gelatinous layer; arranged in radial rows; pits numerous, very small, bordered.

Material: Yale Nos. 787, 2120, 4986 (Cuba); 5021 (S. D.); 5217 (Florida).

HURA

Hura crepitans L., the most important of the two species[153] of this genus, has a very extensive natural distribution in tropical America and is extensively cultivated for shade and decorative purposes in the tropics of both hemispheres. It has various names, the most common

[153] *Hura polyandra* Baill. is a large tree occurring in southern Mexico and southward into Costa Rica, where its range overlaps that of *H. crepitans*. The two species resemble each other very closely, except in the structure of the stamens.

Photo by G. R. Fairbanks.

Rubber Gatherer Smoking Latex of Hevea, Amazon Region.

Photo by W. L. Kann.

Possum Wood or Rakuda Tree in Surinam. (Hura crepitans.)

PLATE XXXVII

being "javillo" (Spanish), "sablier" (French), and sand-box tree (English). The wood has been met with in the markets of the United States under the names of possum wood and hura wood; more recently as "rakuda," a trade-mark used by Mr. W. L. Kann of Pittsburgh, Pennsylvania, for timber from Surinam.

In Colombia, this tree, often called "ceiba de leche," is common along all the tributaries of the Magdalena River, especially in the region above El Banco. It is sometimes 100 feet high, with a large-limbed, wide-spreading crown, and a trunk that is sometimes six feet or even as much as nine feet in diameter. The bark is rather smooth, except for the multitude of conical prickles which usually beset the lower portion of the trunk, particularly of the young trees. The leaves are of about the size and shape of those of our cottonwood (*Populus deltoides* Marsh.), but are dull on both surfaces and show numerous prominent ribs on the under side. The dark red flowers are borne in the form of a cone, and while not large, are fairly conspicuous on account of their profusion. The fruit is a woody capsule about three inches across and of the shape of a diminutive pumpkin. When ripe these pods burst with considerable violence into many claw-like segments and scatter the round wafer-like seeds in every direction. The old West Indian practice of hollowing out the immature fruits and filling them with blotting sand gave rise to the name sand-box tree. The tree never grows in pure stands in Colombia, but occurs as scattered individuals throughout the forest, rarely more than one or two per acre with a yield not exceeding 2000 board feet. The wood is common in the local markets, though in small quantities, and is used as a cheap substitute for Spanish cedar (*Cedrela*). Its light color is against it, however, and whenever "tolú" (*Bombacopsis*) can be obtained there is little *Hura* lumber in use.

In Venezuela, the "jabillo" is very common along all the streams in the moist valleys of the coast range and is cut in fairly large quantities along Lake Maracaibo and shipped by steamer to the coast ports. It is about the only native lumber found in large quantities in the local markets and is extensively used for boxes, crating, and all kinds of inexpensive construction and carpentry work.

In Trinidad, the tree is very common and tends to form pure stands in moist sandy loam, with upward of 50 trees per acre, the largest having trunks 60 to 75 feet long and six to nine feet in diameter. Dug-out canoes are made from large logs, but in general the timber is little used, as it is difficult to whip-saw because the fibers clog the saw. The yellowish watery sap of the bark is very irritating to the eyes and tends to make the tree unpopular with the woodcutters. The trees are slow

in forming heartwood and accordingly the young or second-growth trees with white wood are known as white sand-box (Eng.), "sablier blanc" (Fr.), or "javillo blanco" (Span.), while the large forest trees with yellow wood are referred to as yellow sand-box, "sablier jaune," or "javillo amarillo."

It is in Surinam, however, that the tree appears to find conditions most favorable for its development, and on the low narrow reefs of the coastal plain near Paramaribo it forms nearly pure stands, estimated to yield from 6000 to 100,000 board feet per acre, averaging at least 25,000 feet over an area of 20,000 acres. The trees reach a maximum height of about 200 feet, with a straight, fairly regular bole, free of branches for 50 to 100 feet and sometimes seven feet in diameter at the top of the swollen base, which extends six, eight, or even ten feet above the ground. The bark of young trees is covered with short, stubby prickles, but these are shed with age and may be entirely absent, except on the branches and upper part of the trunk, in trees 30 inches or more in diameter. On account of the irritating latex in the bark, the tree is sometimes referred to as poison tree by the English. This name has been corrupted by the Bush negroes into "possentrie" and this, in turn, has become the possum tree or possum wood of the Americans. The timber is little used locally.

The wood is not yet established in the American market, though attempts to that end are being made. The soft and light but firm wood is very uniform, easy to work, and can probably be employed successfully as a substitute for many of our soft woods. It has a high, silky luster and enough figure to make it suitable for certain classes of furniture, cabinetwork, and interior trim, being readily stained any desired color. It takes glue well and can be used for plywood and corestock for veneering. With the introduction of modern methods of logging, milling, and drying, the timber will doubtless find a wide range of application in the region of its growth, in place of the coniferous lumber now imported.

THE WOOD

Hura crepitans L. *Possum Wood.*

Common names: Hura wood, possum wood, rakuda (Trade, U. S.); sand-box, sand-box tree, monkey's dinner bell (B. W. I.); javillo, havillo, havarilla, molinillo (P. R.); salvadera, haba, habilla (Cuba); sablier, sabbir (Fr. W. I.); possentrie, postentrie, zaehthout, zandkokerboom (Sur.); white or yellow sand-box, sablier blanc, sablier jaune, javillo blanco, javillo amarillo (Trin.); habilla, ceiba, ceiba amarilla, ceiba de leche, castañeto, arenillo, arenillero, acuapar, mil-pesos (Col.); tronador, white cedar (Pan.); habilla, salvadera

(Peru); ochohó (Boliv.); arceira, assacú, oassacú, guassacú, uassacú (Braz.); ki-semir (Java). Other species: Habilla, jabilla, ovillo, arbol de diablo, cuatatachi, haba, haba de Guatemala, haba de indio, haba de San Ignacio, pepita de San Ignacio, quahayohuatli, quauhtlatlatzin, solimanche (Mex.); tetereta (Guat.); javillo (Salv.).

General properties: Color pale yellow, creamy white, or grayish-yellow to yellowish-brown, often streaked; lustrous. Sapwood white.

Odor and taste absent or not distinctive.

Light and soft, but firm; of about the consistency of basswood (*Tilia*). Sp. gr. (air-dry) 0.36 to 0.44. Weight 23 to 27 lbs. per cu. ft. Somewhat roe- or ribbon-grained. Texture medium; more or less woolly; wood easy to cut, holds its place, takes stains and glue well; dark-colored wood fairly resistant to decay; attacked by shipworms.

Growth rings: Indistinct to distinct; when present, due to slight difference in color and to relative abundance of parenchyma.

Parenchyma: In very fine and extremely numerous lines, extending from ray to ray and producing a very fine wavy pattern (invisible or very indistinct without lens).

Pores: Rather large and distinct; not very numerous; well distributed, occurring singly or more often subdivided radially two to several times.

Vessel lines: Very distinct as coarse lines, usually darker than background; variable from long to short; appearing rather waxy or resinous.

Vessel contents: Tyloses fairly abundant; lustrous. Light-colored gum deposits common.

Rays: Very fine and only faintly visible on cross and tangential sections; visible, but fine and inconspicuous, on radial, where they are of the same color as background.

Ripple marks: Absent; local tendency noted in some specimens.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits rather large and numerous, with rounded or hexagonal borders and lenticular orifices; tyloses thin-walled. Rays homogeneous, uniseriate or occasionally biseriate in part, few to 20 cells high; cells rather large, thin-walled; pits into vessels large, rounded, simple to half-bordered. Parenchyma in irregular tangential rows, one cell wide; larger than fibers; thin-walled; abundant crystals. Fibers thin-walled; in fairly distinct radial arrangement; flattened radially; pits simple or indistinctly bordered; length, min. 1.15 mm., max. 1.80 mm., ave. 1.53 mm.

Remarks: Wood superficially resembles *Simaruba,* but lacks the bitter taste and has parenchyma in very fine and closely spaced lines, visible only under lens.

The wood of *Hura polyandra* Baill., of Central America and Southern Mexico, is practically indistinguishable from that of *H. crepitans. Material:* Yale No. 4407* (Acapulco, Mex.).

Material: Yale Nos. 318, 352, 361, 461*, 466, 469, 4415 (Venez.); 2877* (Curaçao); 4184, 4958 (Sur.); 4061 (Market). Asterisk indicates botanical material.

37. ANACARDIACEAE

The Sumach Family consists of about 60 genera and 500 species of trees, shrubs, and woody climbers, most abundant in warm or tropical regions, a few extending into the temperate zones. It includes the mango, *Mangifera*, certain species of which are planted extensively throughout the tropics and produce edible fruits of considerable economic value. *Pistacia* yields the pistachio nuts of commerce which are used in confectionery. Various genera, *e.g.*, *Rhus*, *Anacardium*, etc., are the source of oils, gums, and varnishes, and many are of exceptional value for tannins and dyes. Chinese gallnuts, containing upward of 70 per cent of tannin, are produced on the leaves of sumach, *Rhus;* the ground leaves of the Sicilian sumach, containing about 28 per cent tannin, are employed in the manufacture of soft leathers for gloves and book bindings and also for mordanting certain basic aniline dyes; the quebracho, *Schinopsis*, of Argentina, is the source of one of the most important vegetable tannins of commerce. Some of the plants are poisonous.

The woods of this family exhibit a wide range of variation in all their properties. That of certain species of *Rhus* is soft and lustrous, with richly variegated coloring of brown, yellow, green, and red. That of *Spondias* is light and coarse, with a dull whitish or grayish color, and is not durable. The woods of *Astronium* are typically hard and heavy, though usually easy to work, are of a deep reddish-brown color often variegated with streaks of black, and have a waxy or oily feel. The quebracho has a uniform reddish color and is one of the hardest, flintiest, and most durable woods known.

The principal structural features of the woods are as follows: The pores are of variable size, sometimes fairly large and distinct (as in *Spondias*, *Mangifera*, and *Anacardium*), but mostly small; evenly distributed or, in a few cases where the trees grow in temperate regions, in ring-porous arrangement (*e.g.*, certain species of *Rhus*); often filled with tyloses; vessel perforations almost exclusively simple; spirals are found in the vessels of *Pistacia* and *Schinus;* pits are usually large. The rays, which are nearly always fine and inconspicuous, are rather coarse in *Spondias;* always heterogeneous. Parenchyma is not very abundantly developed, occurring mostly about the pores, fairly distinct to indistinct. The pits between ray or wood parenchyma cells and the vessels are characteristically large, irregular, both simple and half-bordered, and sometimes elongated and arranged to resemble a scalariform perforation. Ripple marks have not been observed. The wood fibers have simple pits, are sometimes septate, and in the dark-colored woods

may be filled with a gum-like substance, which is also common in the parenchyma.

Gum ducts are of frequent occurrence and provide an important diagnostic feature. Vertical ducts have been observed in only one species, *Drimycarpus racemosus* Hook. f. Canals in some of the rays, sometimes more than one per ray, have been found in representatives of *Astronium*, *Buchanania*, *Gluta*, *Koodersiodendron*, *Loxopterygium*, *Odina*, *Parishia*, *Pistacia*, *Rhus*, *Schinopsis*, *Schinus*, *Spondias*, and *Tapirira*.[154] In the lighter-colored woods the oily exudations may be very distinct, giving a speckled appearance to the tangential surface.

MANGIFERA

The mango, *Mangifera*, is cultivated throughout tropical America and has become widely naturalized. Although there are many species, the best known is *Mangifera indica* L., a large, round-topped, evergreen tree, sometimes 60 to 75 feet high and from two to six feet in diameter. The succulent fruit is greatly relished by the native population. The wood is of good quality for general carpentry, being only moderately hard, heavy, and tough, easy to work, and taking a good finish. The timber is largely sapwood, which is of a grayish-brown color with yellowish vessel lines; the heartwood is a light chocolate-brown. In texture it suggests ash (*Fraxinus*) and is used for much the same purposes. The pores resemble pinholes, are evenly distributed, fairly numerous, but not crowded, occurring singly or appearing subdivided two to several times. Tyloses are often present; sometimes gummy. Parenchyma forms inconspicuous patches about the pores and is also in rather indistinct concentric bands which sometimes appear to limit growth rings. The rays are at the limit of vision on cross and tangential sections and fairly distinct on the radial. Gum ducts have not been observed. The common names are: Mango, mango tree (Eng.); mango (Span.); manguier (Fr.); mangueira (Port.); manguier, mangottier, mangot (Guad.); mangotier (Trin.). *Material:* Yale Nos. 733 (Cuba); 2700, 4541, 4619 (P. R.); 2199 (P. I.).

ANACARDIUM

There are a dozen or more species of this genus. The "cajú do matto," *Anacardium giganteum* Hanc., is said to be one of the largest trees in the Amazon forest, yielding a soft wood of little or no utility at present. The "cajú-açú" or "cajú-assú," *A. Spruceanum* Benth., also of the

[154] See Record, S. J.: Intercellular canals in dicotyledonous woods, *Journ. Forestry*, 16: 4: 428-441; 19: 3: 255-266.

Amazon, attains a height of 90 to 100 feet with a straight and slightly tapered bole three feet in diameter and with a clear length of 50 feet or more. The bark is highly resinous.

The cashew, *Anacardium occidentale* L., is a small tree indigenous to the West Indies, but widely cultivated on account of its nuts, the cashew nuts, which are edible when roasted and which also yield a yellow oil similar to that of the almond. The soft shell is the source of anacardic acid and of a very caustic oil, cardol, which is used medicinally and, in India, to preserve woodwork and bookbindings from the ravages of termites and other insects. The gummy exudations of the bark are known as acajou gum. The wood is lustrous and of a grayish, pinkish, or brownish color; it is moderately hard and strong, easy to work, not very resistant to decay. The pores are small, but visible, isolated or in groups of two to four, evenly distributed, and surrounded by parenchyma. The rays are fine and indistinct. Resin ducts have not been observed. The wood is used locally to some extent for boxes, general carpentry, ox-yokes, implements, and vehicles. The common names are: Cashew, cashew tree, cashew-nut tree (B. W. I.); pajuil, cacahuil, cajuil, acajú, marañón (P. R.); acajou (Fr. W. I.); pomme d'acajou, merey (Trin.); cajú, cajú-assú, cajueiro, cajueiro do campo (Braz.); marañon (Peru, Col., C. A., Mex.); merey (Col.); cajuil (Venez.); kaschu-baum, acajou-baum (Germ.). *Material:* Yale Nos. 2701 (P. R.); 2729 (C. R.); 3785 (India); 4802 (Haiti).

A larger tree and one yielding timber of more or less commercial importance is *Anacardium Rhinocarpus* DC., the "caracoli" of Venezuela, Colombia, and eastern Panama, the "espavé" of Panama, and the "espavel" of Costa Rica. In Colombia it reaches a height of over 100 feet with a very irregular bole, sometimes growing in almost pure stands. It is abundant in the lower Magdalena Basin, and south of the savannas near El Banco it is along the water courses and extends back to elevations of about 1000 feet. Where the trees have sufficient light they develop short boles and very coarse-limbed crowns, but when crowded they are often of good form with clear lengths of 50 feet or more. There is very little demand for the timber, but it should prove very useful for boxboards; it is said to be of better quality than the "espavé" of Panama.

Along the Bayano River in Panama this species grows in dense forests and reaches a height of 80 to 120 feet with a cylindrical trunk three to five feet in diameter above the slight root swelling, and clear of branches for from 40 to 60 feet. The fleshy peduncles of the fruit are edible and the natives macerate the bark in water and use it to stupefy fish. The wood is used locally for dugout canoes, kitchen utensils, and

miscellaneous minor purposes. Attempt has been made to establish a market for the timber in the United States under the name of espavé mahogany, but the efforts have so far been unsuccessful.

THE WOOD

Anacardium Rhinocarpus DC. *Espavé.*

Common names: Espavé (or espava), espavé mahogany, Pesége mahogany (Trade); espavé, espavel, aspavé (C. A.); caracolí (Col.); caracoli, mija, mijagua (Venez.); giant cashew tree.

General properties: Color variegated light brown, pinkish-brown, or yellow; lustrous; darkening upon exposure. Sapwood gray, often with yellowish streaks.

Odor and taste absent or not distinctive.

Light and soft, but firm. Sp. gr. (air-dry) 0.54. Weight about 34 lbs. per cu. ft. Grain often roey, producing striped effect. Texture rather fine. Wood has about the consistency of cedar (*Cedrela*), is very easy to cut, takes a high natural finish, is tough and fairly strong, holds nails well, appears fairly durable.

Growth rings: Present, but not always clearly defined; due to differences in density which are sometimes rather highly pronounced.

Parenchyma: In association with pores; not conspicuous.

Pores: Resembling small pinholes; few; scattered; occurring singly or sometimes subdivided; usually filled with lustrous tyloses.

Vessel lines: Very distinct; appearing considerably darker than background.

Vessel contents: Thin-walled tyloses abundant; sometimes gummy.

Rays: Fine; faintly visible on cross and tangential sections; very distinct on radial.

Ripple marks: Absent.

Gum ducts: None observed.

Material: Yale Nos. 341, 462* (Venez.); 421*, 1544*, 1582, 3966* (Col.); 2728 (C. R.). Asterisk indicates botanical material.

SPONDIAS

Of the 15 or more species of this genus, the best known and most widely distributed, both naturally and artificially, are *Spondias purpurea* L. (= *S. Mombin* L.) and *S. lutea* L. Both are esteemed for their edible fruit and are very commonly planted for shade trees and for fencing. Sections from six to 12 feet long and four to 18 inches thick are cut from the limbs of old trees or out of the trunks of young trees and set close together in the ground, whereupon they take root and grow. In Venezuela the timber, known as "jobo," is used for making match-sticks.

The "cajaseiro" of eastern Brazil, *Spondias dulcis* Forst., is a com-

mon tree in virgin forests and more abundant in the second growth, where it makes up as much as 50 per cent of the stand. It reaches a height of 125 feet, with a fairly symmetrical bole two to four feet in diameter and free of branches to upward of 60 feet. The timber is not on the market and is considered useless. It is almost impossible to air-season the timber, as it is very susceptible to decay and is also attacked by boring beetles almost as soon as felled and soon reduced to powder. If cut into boards and kiln-dried, it would doubtless prove highly suitable for boxes. It is soft, but firm and tenacious, holds nails well, is nearly colorless, and can be had in large sizes with few defects.

The woods of the various species of *Spondias* are very much alike. They are very coarse-textured, have numerous large pores and distinct rays, and suggest *Ceiba*, except that parenchyma lines are absent. Growth rings are sometimes fairly distinct, due to slight differences in density. Large intercellular canals have been observed in *S. lutea* and certain other species. They are wanting in "cajaseiro" (Yale No. 1779), but very large, thin-walled resin cells occur in association with the margins of the rays and with the wood parenchyma strands. The wood fibers are thin-walled and septate. *Material:* Yale Nos. 420, 1522* (Col.); 2671 (Venez.); 4803*, 4829* (Haiti); 5005 (Cuba). Asterisk indicates botanical material.

Common names of the American species: Hog plum, Spanish plum, poison wood (Eng.); ciruela agria, c. campechana, c. loca, jobito, jobo hembra, j. negro (Cuba); ciruela, c. del país, jobillo, jobo francés (P. R.); mombin, jobo (Mart.); prune d'Amérique (Guad.); mombin, jobo, jovo (Trin.); mombin, pomme cythère (Fr. G.); mopé, fransi mopé (Sur.); ciruelo de hueso (Venez.); hobo, jobo, ciruela calentana (Col.); cajaseiro, cajazuero, cajá comun, c. manga, c. do sertão, pomo de Venus, imbuzeiro, taperebá (Braz.); ciruelo (C. A., gen.); jocote tronador, sismoyo (C. R.); jocote de jobo (Nic.); palo de mulato (Guat.); abal, atoyaxocotl, atoyaxotl, biaxhi, capuatl-cacao, chiabal, chupandilla, ciruelo, ciruela agria, c. amarilla, c. colorada, c. de Mexico, c. del país, c. obo, c. rojo, costixocotl, cozticxocotl, coztilxocotl, cupu, hobo, jobo, j. espino, j. roñoso, jocote, jovo, macaxocotl, mazaxochotli, mompin, obo de zopilote, pompoqua, popoaqua, xkinin-hobó, xobo, xocot (Mex.); prunier d'Espagne, mombinpflaume, gelbe mombinpflaume (Misc.).

TAPIRIRA

The dozen or more species of trees and shrubs composing this genus are widely distributed throughout tropical South America and Central America. *Tapirira chagrensis* Pittier is about 65 feet high, with a straight trunk 18 to 20 inches in diameter and free of branches for 25 or 30 feet; it is a common tree of the forests on the dry limestone hills

in the Middle Chagres Valley of Panama. *T. myriantha* T. & P. is known only from the Choco Province on the Pacific coast of Colombia and from the coast of San Blas in Panama; it is a tree 80 feet or more in height and about 30 inches in diameter. An oily resinous fluid is collected by the natives from incisions in the bark and used medicinally. The common names in the Province of Colon are "bagamani," "vagamani," or "vanamani." The woods of these species are not utilized to any appreciable extent.

There are various species of *Tapirira* in Brazil and the Guianas. One of these, known as "duka" in British Guiana, furnishes a light, soft, pinkish wood usually speckled with black exudations from the canals in the rays. It is said that the tree often has a clear length of 40 feet that will square up to 17 inches. The wood is not resistant to decay or to insect attacks and is serviceable only for general carpentry in protected places. It has little to commend it as a furniture wood. The heavier grades of this wood are much the same as the "páo pombo" of northern and eastern Brazil, *Tapirira guianensis* Aubl. This is a tree of medium height, of common occurrence, with a wood of good quality used for general carpentry, interior construction, and to some extent in boatbuilding.

The woods of the several species of this genus are very much alike, the chief difference being in the density, which ranges from specific gravity 0.55 to 0.75. The harder kinds are of about the consistency of birch (*Betula*) and could be used for much the same purposes. The softer grades are suitable for cheap construction and miscellaneous minor purposes.

THE WOOD

Tapirira guianensis Aubl. *Páo Pombo.*

Common names of this and closely related species: Páo pombo, fruta de pomba (Braz.); tapiriri (Galibis); duka, dooka (B.G.); bois tapiré (Fr.G.).

General properties: Color pinkish or pinkish-gray, darkening upon exposure; somewhat lustrous. Sapwood lighter, not very sharply defined. Surface often speckled more or less distinctly from gummy exudations.

Odor and taste absent or not distinctive.

Rather hard to moderately soft, but firm and tenacious. Sp. gr. (air-dry) 0.54. Weight about 34 lbs. per cu. ft. Grain straight or fairly so. Texture medium to fine. Wood easy to work, takes good polish, holds nails well; is not durable.

Growth rings: Present, but inconspicuous; due to slight differences in color and sometimes to terminal parenchyma.

Parenchyma: Not visible without lens; sometimes associated with pores and in indistinct tangential lines.

Pores: Small; visible, but inconspicuous; fairly numerous, but not crowded; occurring singly or as though subdivided radially.

Vessel lines: Fine, long, straight; distinct, but not conspicuous; darker than background.

Vessel contents: Tyloses present.

Rays: Fine, but visible, on cross and tangential sections; very distinct on radial surface, being fairly uniform in height and darker than background.

Ripple marks: Absent or with local tendency to thin formation.

Gum ducts: Common in rays; visible under lens as black dots on tangential and as dark lines in rays on radial. Exudations produce oily specks on wood, visible on tangential surface. Gum pockets filled with paraffine-like substance noted in one specimen (No. 3490).

Remarks: The wood of *T. chagrensis* Pittier (No. 3016) is somewhat harder and heavier than the above; pith flecks are common.

Material: Yale Nos. 3390A, 3490, 3505 (Braz.); 3038* (B. G.); 3016* (Pan.). Asterisk indicates botanical material.

SCHINUS

This genus, with 15 to 20 species of trees and shrubs, is most abundant in the south central portions of South America. The best known and most widely distributed tree is the pepper tree, *S. Molle* L., the natural range of which extends from Mexico to Chile, southern Brazil, and Uruguay, and which has been planted for decorative purposes in tropical and sub-tropical regions the world over. It yields a resin called American mastic, and the bark, "cortex mollis," is also medicinal. The wood resembles elm (*Ulmus*), is moderately hard and heavy, tough, coarse-textured, and of a grayish or brown color. The rays are very fine and indistinct and in the only specimen available (Yale No. 1092*) do not contain resin ducts. The common names of this tree are: Pepper tree (Eng.); aroeira molle (Braz.); molle, molle de Bolivia, molle del Peru, molle de castilla, aguaribay, balsamo, terebinto, pimiento (Arg.); pimentero (Chile); molle, mulli (Peru); muelle, pimiento (Col.); pimento de California (C. R.); arbol del Peru, copal quahuitl, molle, pelonquahuitl, Peru, pimienta de America, pirul, ttzacthûmi, ttzacthunni, xâza (Mex.).

There are various other species of *Schinus* of common occurrence in Argentina and Brazil. The wood of *S. weinmanniaefolius* Engl. is of a light purple or purplish-brown color with a yellowish-gray sapwood, and is moderately hard, fine-textured, very easy to work, takes a high polish, and appears durable. The growth rings are fairly distinct; the pores are very small, faintly visible in wavy bands or festoons suggesting *Ulmus*, and producing a fine pattern on tangential surface. The rays are invisible on cross and tangential sections and scarcely distinct on

the radial; sometimes with gum ducts visible under lens. In this, as apparently in the woods of all other species of *Schinus*, the vessels have spiral markings. The wood suggests red cedar (*Juniperus*) in color and the ease and smoothness with which it cuts. *Material:* Yale No. 1096* (Arg.). The common names are: Corazon de bugre, aroeira colorada. Other species: Molle, molle blanco, molle morado, molle de curtir, aroeira blanca, chichitá mononi, litre (Arg.); aroeira, aroeira do campo, aroeira vermelha (Braz.).

COMOCLADIA

Comocladia, with about 25 species of shrubs and small slender trees rarely over 30 feet high, occurs in Mexico, Central America, northern South America, and more abundantly in the West Indies. The wood is hard, heavier than water, compact, very durable, fine-textured, straight-grained, and of a uniform light reddish-brown color becoming deep red upon exposure. It most closely resembles some of the harder and finer-textured specimens of *Astronium*. It is rich in tannin and the extract is sometimes used as a dye. The common names are: Guao (Cuba); bressilet franc, chicarrón (S. D.); carrasco, maiz tostado (P. R.); chinil-té, hincha huevos, pata de pava, tatatián, tatatil, teclatilla, tetlate (Mex.). *Material:* Yale Nos. 2127 (Cuba); 4768* (*C. repanda* Blake of Oaxaca, Mex.; Blake's Nos. 3684).

METOPIUM

Metopium,[155] with two or three species, is confined to the West Indies and southern Florida. Best known and most widely distributed is *M. toxiferum* (L.) K. & U., a poisonous tree frequently 35 to 40 feet high, with a short trunk sometimes two feet in diameter. A resinous gum, the so-called doctor gum, is obtained from incisions made in the bark and used for medicinal purposes. The wood, which is of a rich dark brown color streaked with red, is hard and heavy, rather fine-textured, not very easy to work, takes a high polish, and is strong and fairly durable. The material is little used, but is suitable for inlay work and for furniture. The common names are: Poison wood, poison tree, hog plum, hog gum, bumwood, doctor gum, coral sumach, mountain manchineel (Fla., B. W. I.); cedro prieto, papayo (P. R.); guao de costa (Cuba). *Material:* Yale No. 815 (Cuba).

MOSQUITOXYLUM

The mosquito wood of Jamaica, *Mosquitoxylum jamaicense* K. & U., also occurs sparingly in Panama, where it is known as "jobillo."

[155] Some botanists include *Metopium* in the genus *Rhus*.

It attains a height of 80 feet, with a straight trunk sometimes 16 or 18 inches through. The bark contains a large quantity of odorous, resin-like latex. When the seeds are ripe the crowns of the tree appear to be painted red and are conspicuous objects in the forest. The heartwood is of a pale reddish-brown color tinged with yellow and is distinct from the grayish sapwood; it is hard, heavy, strong, cross-grained, rather fine-textured, not very easy to work, takes a high polish, is only moderately durable. The pores are small, but visible, numerous, but not crowded, well distributed, occurring singly or in small groups. Wood parenchyma is sparingly developed and not visible. The rays are very fine, faintly visible on cross and tangential sections, and uniformly low, but fairly distinct, on the radial surface, where they are darker than the background. Gum ducts have not been observed. Material: Yale No. 2954* (Pan.).

RHUS

The sumach genus, with about 150 species of shrubs and small trees, is common in tropical, sub-tropical, and temperate regions of the world. Several species are of economic importance on account of their leaves and galls which supply tanning and dyeing materials, while some others yield lacquer varnish and wax. Some of the plants contain acids and oils which are highly irritant to the skin and produce dermatitis. The woods vary from light, soft, and coarse-textured to hard, heavy, and compact, and are usually highly colored, often richly variegated. Very small resin ducts have been noted in the rays of a few species. On account of the small sizes obtainable, the woods are rarely used except for fancy articles and for fuel. *R. integrifolia* B. & H. attains a height of 30 feet with a short stout trunk from two to three feet in diameter in Lower California, and has a hard, heavy, bright, clear red wood sometimes called mahogany. *R. juglandifolia* H. B. K. is very common in northern South America and has a soft, lustrous, yellowish-brown wood. Its common names are: Fresno, ajicito, caspi, manzanillo, birringo, Pedro Hernández (Col.); hinchador (C. R.); yagalache (Mex.); incati (Peru). *Material:* Yale Nos. 815 (Cuba); 2567 (Col.).

ASTRONIUM

This very important genus consists of 12 to 15 known species of medium-sized to large trees. It appears to be poorly represented in the Amazon region of Brazil, the West Indies, the Guianas, and Venezuela, but elsewhere in tropical America the trees are of common occurrence, and yield many minor products of local value, though their chief importance lies in their woods. These exhibit considerable variation in density

and color. At one extreme is a wood resembling quebracho; it has a fairly uniform cherry-red to deep red color, is highly durable and very hard, the specific gravity ranging up to 1.30. No structural feature has so far been noted which will always serve to separate these woods from quebracho (*Schinopsis*), but in general they are less cross-grained, not quite so flinty, appear oilier, and the line of demarcation between heartwood and sapwood is much sharper. Many of the woods of this genus, particularly those growing in the rain forests, are more or less conspicuously marked with vertical bands of dark brown or black, often producing a very striking and beautiful effect and giving the material importance for cabinetwork and fine furniture. Some of these variegated woods are extremely hard and heavy, others are only moderately so, and some exhibit considerable local variation in density, the darker zones being the denser. Ducts are present in the rays and are visible with a lens as fine black dots on tangential section and as narrow dark lines on the radial; sometimes they are visible without a lens, especially when the oily exudations have specked the surface. The woods of the genus are generally easy to recognize, but the material and information available will not justify treatment by species. Moreover, it seems likely that the variation within a species may be as great as that between different species. The woods are accordingly treated here from a geographical standpoint.

Argentina and Paraguay. Two species have been described from this region, namely, *Astronium Balansae* Engl. and *A. Candollei* Engl., and there are probably others, including *A. Urundeuva* Engl. They are commonly known as "urunday." The country where they grow is comparatively dry and consequently the trees are of rather low stature, 35 to 60 feet, with stout trunks sometimes three to four feet through. The yellowish sapwood is not very thick and is sharply defined from the heartwood, which is cherry-red or reddish-brown when fresh, becoming deep claret-red upon exposure. The woods are hard and heavy to extremely so, the specific gravity being as great in some instances as 1.30 and nearly always greater than 1.00; the sapwood is not as hard as the heartwood. Growth rings are poorly defined. Parenchyma, visible only under the lens, is about the pores and occasionally in very fine tangential or concentric lines. The pores are small, but visible, scattered singly or in short radial groups, closed with tyloses. The vessel lines are dark-colored and usually very distinct on fresh material. The rays are fine and ordinarily are visible on radial surface only.

The woods are used for cross-ties, posts, piling, bridge timbers, and other heavy construction, axles of heavy vehicles, and also for furniture,

cabinetwork, and turnery. The common names are: Urunday, urundai, urundey, urundel, urunday crespo, urunday-mi, urunday pardo, urunday pichái. *Material:* Yale Nos. 1046*, 1080*, 1117, 1118, 3973 (Arg.); 4392, 4394 (Par.). Asterisk indicates botanical material.

Brazil. There are at least five, probably several more, species in Brazil, but the information concerning them is meager and often confusing. In the dry interior is *Astronium Urundeuva* Engl., a rather small tree, 30 to 50 feet in height, with trunks 20 to 25 feet long and 16 to 24 inches in diameter. The wood is much like that of Argentina and Paraguay, though more inclined to warp and shrink in drying and consequently is not suited for lumber. It is very durable and strong, and is particularly suited for use in the round in damp situations and in work exposed to the action of water. The common names are: Urundeuva, orendeuva, aroeira do campo, aroeira preta, aroeira do sertão, coronilla. *Material:* Yale Nos. 4742, 4756.

The name "aroeira" (with or without qualifying terms) is applied to other species of *Astronium* and also to *Schinus*. The authors are of the opinion that the commercial woods referred to by this name are not *Schinus*, since the structure, so far as indicated by available material, is essentially different. The trees, which occur scatteringly in the States of São Paulo and Minas Geraes, are said to be small and of irregular growth, 30 to 45 feet high, with trunks 20 to 25 feet long and from 16 to 20 inches through. There are different grades of the wood, but the best is very hard and heavy, difficult to work, of a red color, sometimes with black layers, and is highly durable. It is considered the best wood in São Paulo for exterior woodwork and structures in damp situations. It appears to be very rich in tannin. *Material:* Yale Nos. 1469, 1472, 2519, 2521, 3435, 3436, and 3444. (Specimen No. 1482 from Minas Geraes, apparently belonging to this group, is labeled "páo ferro claro.")

There is another tree, or more likely a group, known as "aderno" and "gibatão," variously referred to *Astronium commune* Jacq. (?), *A. concinnum* Schott, and *A. gracile*. The wood is yellowish, brownish, or reddish with lighter or darker variegations. The trees are said to be large, but not very common. The wood is used for cabinetwork, turnery, and construction, and the heavier and darker-colored grades are in demand for railway cross-ties, bridges, and other purposes requiring strength and durability. The common names (which may be only in part synonymous) are: Aderno, aderno preto, aderne, ubatan, ubatan amarello, ubatão, jubatan, ybatan, gibitan, gibatão, chibatão, chibatão pedro, chibatão vidrado. *Material:* Yale Nos. 1470, 3263*.

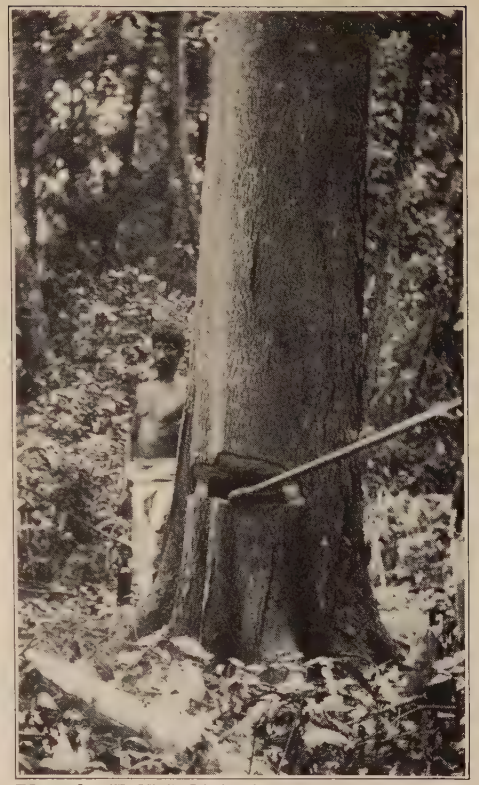


Photo by H. N. Whitford.

Gonçalo Alves in Espirito Santo, Brazil.

(*Astronium fraxinifolium.*)

Photo by H. M. Curran.

Quebracho in Interior of Bahia, Brazil.

(*Schinopsis brasiliensis.*)

One of the finest timbers in Brazil is the "gonçalo alves," commonly referred to *A. fraxinifolium* Schott. This is a well-known, though comparatively rare, tree scattered through the coastal mountain forests where it attains a height of 100 feet and a diameter of two to three feet. It is beautifully figured and is highly esteemed for the manufacture of fine furniture. The darker and heavier grades make good railway ties and are useful for any purpose requiring a strong and durable wood. It is often mixed in shipments of Brazilian rosewood (*Dalbergia nigra*) and is known in the furniture trade as zebra wood, and sometimes as kingwood.

THE WOOD

Astronium fraxinifolium Schott — *Gonçalo Alves.*

Common names: Gonçalo alves, gonçalo alves rajado branco or preto, guarabú rajado, guarabú batata, guarabú encirado, jejuira, muiraquatiara (Braz.); zebra wood, kingwood (Trade).

General properties: Color light to dark brown or reddish, with black stripes which may predominate; dark areas look oily, lighter portions deepen upon exposure. Sapwood grayish; sharply defined.

Odor and taste not distinctive.

Mostly hard and heavy. Sp. gr. 0.85 to 1.00. Weight 53 to 62 lbs. per cu. ft. Grain straight or roey. Texture rather fine. Wood takes high polish; some specimens are hard to cut, other comparatively easy; dark specimens very durable; has striking and often beautiful figure.

Growth rings: Bands of black, usually of variable width and continuity, are sometimes disposed regularly enough to form growth rings. These dark areas, which are denser than the light portions, appear to begin rather than end the growth rings, since the inner edge is more sharply defined than the outer.

Parenchyma: Not distinct even with lens.

Pores: Small, but usually distinct, especially in dark bands. Usually well distributed; occurring singly or more often in small groups.

Vessel lines: Fine; not distinct; plainest on dark layers.

Vessel contents: Tyloses and occasionally white substance present.

Rays: Fine, visible without lens, at least in darker areas; low, but distinct, on radial surface, appearing either lighter or darker than background, depending upon its color.

Ripple marks: Absent.

Gum ducts: Present in some of the rays; showing as small black dots on tangential surface; contents oily.

Material: Yale Nos. 3182, 3255*, 4102, 4253, 4272, 4676* (Braz.). Asterisk indicates botanical material.

Venezuela and Colombia. The important species in this region is said to be *Astronium graveolens* Jacq. Mr. Curran supplies the following information regarding it: "This is another form of the tree and timber

known as "gonçalo alves" in Brazil. I am acquainted with it only in the Magdalena valley of Colombia, where it occurs scatteringly in the lowland forests. It attains a height of 100 feet or more, with commercial lengths of 50 feet and diameters up to three feet. It is a symmetrical tree, only slightly buttressed, and has a rather thin, but somewhat rough bark of a brown or grayish color. It is considered the best timber in the Magdalena valley for house posts. The heartwood has dark brown or black markings and takes a beautiful finish. The timber is commonly met with, though in small quantities, in the markets of both countries and is highly esteemed for cabinet work and fine furniture." The common names are: Gateado (Venez.); diomate, yomate, gusanero, tibigaro, marfil vegetal (Col.). *Material:* Yale Nos. 321, 337, 6668 (Venez.); 379, 418*, 515 (Col.).

Mexico and Central America. There are doubtless several species of *Astronium* in this region, but there is little information available regarding them. The woods are hard and heavy, of a red or reddish-brown color, often streaked with black; they are very durable and are used locally for exposed structures, house construction, and in some instances, at least, for furniture. The local names are: Ronron, maquelizo, masicorán, ciruello, sirguelillo (Hond.); palo obero, ciruello (Guat.); soro or cero (Pan.); cero, culebra, palo de cera, sangualica,[156] sangolica, zongolica, yaga-biche (Mex.). *Material:* Yale Nos. 103, 125, 6630 (Hond.); 3687* (Guat.); 4772 (Nic.); 4732*, 4759* (Mex.). Asterisk indicates botanical material.

LOXOPTERYGIUM

Of the four species occurring in various parts of South America, the best known wood is the "hoobooballi," *Loxopterygium Sagotii* Hook. f., of the Guianas, the identity of which has only recently been established.[157] The tree is said to be common in the forests, attaining a height of 100 feet and diameter great enough to square 20 inches. The smoothish or wrinkled bark contains a light greenish-yellow sticky latex. The unequally pinnate leaves have several pairs of rather large leaflets and

[156] *A. Conzattii* Blake of Oxaca. The wood is very hard and fine-textured with prominent black layers. *Material:* Yale No. 4759*.

[157] This wood has been referred to by various writers as belonging to the Leguminosae, Meliaceae, and Sapindaceae. The structure of the wood, particularly the presence of gum ducts in the rays, convinced the authors that it belonged to the Anacardiaceae, near *Astronium*, and through the efforts of Dr. J. W. Gonggrijp, Conservator of Forests of Surinam, the correct identity was subsequently established, his findings being later confirmed by Dr. S. F. Blake of the U. S. Bureau of Plant Industry.

suggest ash (*Fraxinus*). The flowers are very small and borne in long, compound, axillary racemes; the fruits are samaras resembling those of maple (*Acer*).

The light brown or reddish-brown wood is streaked with darker color as in some of the species of *Astronium*. It varies from rather light to moderately hard, averaging about 40 pounds per cubic foot. It is used for boatbuilding, especially for the bottoms, and for furniture and gunstocks. There is no evidence that it enters the foreign trade.

THE WOOD

Loxopterygium Sagotii Hook. f. *Hoobooballi.*

Common names: Hoobooballi, hububalli, hubaballi, houbooballi, hoeboeballi, hoboballi (Arowak); kooël pialli (Caraib); snaki hoodoo, boosi mahoni (Negro English); slangenhout (Dutch); Surinam snakewood (Eng.).

General properties: Color brown or reddish-brown, with dark concentric layers of varying width and regularity; usually flecked with small oil specks. Rather thick sapwood gray; not sharply defined.

Without distinct odor or taste.

Rather light and soft to moderately hard and heavy. Sp. gr. (air-dry) 0.60 to 0.70. Weight 37 to 43 lbs. per cu. ft. Grain fairly straight. Texture medium. Easy to work, finishes smoothly, polishes fairly well, but is likely to become stained with oily exudations; appears durable.

Growth rings: Sometimes very distinct, due to dark bands; elsewhere may be indistinct.

Parenchyma: In indistinct layer about pores.

Pores: Rather small; very distinct in dark bands, visible elsewhere; fairly numerous; well distributed; mostly in radial groups of few to several pores each.

Vessel lines: Fine and inconspicuous in light areas, distinct in dark patches where they appear considerably lighter than background.

Vessel contents: Some tyloses present.

Rays: Very fine; mostly invisible on cross and tangential sections; fairly distinct on radial.

Ripple marks: Absent.

Gum ducts: Radial ducts common, their contents exuding to speck the tangential surface and to produce distinct lines on the radial.

Material: Yale Nos. 4287, 5090* (B. G.); 3027A, 4185, 5881* (Sur.). Asterisk indicates botanical material.

SCHINOPSIS (QUEBRACHIA)

This genus is the source of the valuable South American tanwood known as quebracho. This name is a contraction of the colloquial Spanish and Portuguese term "quiebra-hacha" (ax-breaker), originally

applied to many trees in Latin America, and refers to the flinty hardness of the wood. There are two kinds of quebracho—the red or "quebracho colorado," the product of this genus, and the white or "quebracho blanco" supplied by a species of *Aspidosperma* (Apocynaceae).

Although at least eight different species of *Schinopsis* have been described by botanists, there are only two that are generally recognized as of commercial importance, namely, *S. Lorentzii* Engl. (= *Quebrachia Lorentzii* Gris. = *Loxopterygium Lorentzii* Gris.), a deciduous tree with compound sumach-like leaves, and *S. Balansae* Engl., a tree never entirely free of leaves, which in this case are simple and suggest those of willow oak (*Quercus phellos*) though showing transitions to the compound form of the other. The former, which is more abundant in the drier western plains, is sometimes referred to as the Santiago type, while the latter, which extends into the swampy lands fringing the Paraná and Paraguay Rivers, is known as the Santa Fé type. The two kinds are much alike as to flowers, which are small and inconspicuous; fruits, which are maple-like; and woods, which are of a deep rich red color that darkens upon exposure and are a third heavier than water.

The botanical range of *Schinopsis* extends over northern Argentina, western Paraguay, a small portion of Bolivia, and an undetermined area in Brazil as far north as the interior of the State of Bahia. The commercial range includes the northern half of the Province of Santa Fé, the eastern part of the Province of Santiago del Estero, all of the Territories of Chaco and Formosa, and a narrow fringe east of the Rio Paraná in the Province of Corrientes in Argentina, and throughout the explored country west of the Rio Paraguay in Paraguay. The extent of this commercial range is approximately 200,000 square miles and embraces practically all of the country known as El Gran Chaco, a vast flat, poorly explored region of mingled jungles and open pampas, inhabited only by nomadic Indian tribes. Extensive areas have been destroyed by fire and wasteful logging.

The trees grow singly or in small groups in mixture with other hardwoods in open stands or islands, and the spaces between the islands are usually covered with an almost impenetrable tangle of vines, thornbushes, and cactus. They are from 30 to 50 feet high, one to three feet in diameter, and clear of branches for 20 to 30 feet. They are of scrubby growth and their trunks are often bent and twisted, and swollen at the base. The number of trees per acre rarely averages more than five.

The heartwood of quebracho contains from 20 to 30 per cent of tannin, and 3 or 4 per cent of soluble non-tannin. The sapwood, which is from one to three inches thick, contains only about 3 per cent of tannin and 8 per cent soluble non-tannin. The tannin and soluble non-

Photo by H. C. Kluge.

Logging Quebracho by Modern Methods in Argentina.

Photo by H. M. Curran.

Quebracho Logs at Extract Plant in Argentina.

tannin content of the bark are each about 10 per cent. The usefulness of quebracho is almost entirely dependent on the tannin content of the heartwood, deriving therefrom its great durability as well as its high economic importance as a source of extract. The extract industry, which started in a small way about 1895, is now one of the most important industries of Argentina and Paraguay.

The trees are felled by means of heavy axes, and the bark and white sapwood are hewn off to reduce the weight of the logs and also to prevent the attack of beetles which deposit their eggs in the bark of down timber and fire-damaged trees. The resulting larvae will within six months completely riddle the wood with their galleries. The larger limbs are sometimes used for tanwood and the smaller ones are cut into firewood, if not too far from market.

The logs are dragged by oxen through narrow paths to wider lanes, called "picadas," which had previously been hewn out from the railroad. They are then loaded on heavy carts and hauled out, two or three tons at a time, to the narrow-gauge logging road where they are swung onto cars and drawn out to the extract factory by means of small wood-burning locomotives. (Plate XVI.)

At the extract plant the logs are reduced to chips by mechanical means. These chips are run into copper vats, leached with hot water, and the resulting liquor evaporated in vacuum pans to the consistency of syrup. This is further concentrated by heating and stirring in another type of evaporator and is then run into bags and allowed to cool and harden. It is exported in this form and contains about 65 per cent tannin, 10 per cent soluble non-tannin (mostly coloring matter), and 25 per cent moisture. The spent chips are allowed to dry and are then used for fuel. Logs may be stored for long periods in the open with only superficial loss of tannin, but users prefer fresh wood because it is easier to chip.

Formerly the logs were exported in great quantities to the United States and European countries where the extract was prepared, but the local extracting industry has gradually developed until there are now about 20 factories in operation in northern Argentina and western Paraguay. The monthly capacities of these plants range from 250 to 2500 tons of solid extract, the total annual output being normally between 150,000 and 200,000 tons.

Quebracho timber has many other uses. It is seldom cut into boards because of the difficulty of sawing and also because thin lumber has a great tendency to check and warp. Practically all of the fence posts, telegraph poles, bridge timbers, and railway ties in the region are of quebracho, which is one of the most durable woods known. It is highly

important for fuel, and is extentively used not only for household purposes, but also by factories, power plants, locomotives, and the smaller river steamers. It is also used for wood-block paving, heavy construction, and cart axles.

The quebracho of Bahia, Brazil, commonly called "baraúna,"[158] is *Schinopsis brasiliensis* Engl. This is a common tree of the dry forest and, while its range has not been determined, it probably extends southward until it meets or merges into other species. It occurs in nearly pure stands or in association with "aroeira" (*Astronium* or *Schinus*) and a number of other dry-forest trees. The forest is thin and open, with a dense undergrowth of thorny shrubs and cactus. The mature trees are 40 to 50 feet high with a much-branched bushy crown suggesting an oak tree grown in the open. The trunks are short, rarely over 20 feet, with diameters up to two feet. The bark is thick, rough, and black, suggesting certain oaks. The leaves, which are one to five inches long, are oddly pinnate, with two to eight pairs of leathery leaflets, the largest about one inch long and half as wide. The winged fruits suggest those of maple (*Acer*) and are about 1.5 inch long and 0.5 inch wide. The wood is practically identical in appearance and structure with the quebracho of Argentina. It is confused locally with "aroeira" and is little used. (From data and specimens supplied by Mr. Curran.)

THE WOOD

Schinopsis spp. *Quebracho.*

Common names: Quebracho (Trade); quebracho, quebracho colorado, quebracho negro, quebracho moro, quebracho macho, quebracho chaqueno, quebracho crespo (Arg.); soto negro (Boliv.); quebracho (Matto Grosso, Braz.); baraúna (Bahia, Braz.); ironwood, red lignum-vitae, quiebra-hacha, break-axe, axe-master (Misc.).

General properties: Color cherry-red, darkening upon exposure; weathers gray on surface after long exposure. Sapwood white or yellowish; very distinct, though the line of demarcation is not sharp.

Odorless. Taste astringent.

Wood extremely hard and flinty. Sp. gr. (oven-dry) 1.15 to 1.30. Weight 70 to 80 lbs. per cu. ft. Grain irregular, roey. Texture fine and uniform. Wood very hard to work, takes a high polish, very strong, but brittle, extremely durable.

Growth rings: Present, but inconspicuous; due sometimes to fine line of wood parenchyma and sometimes also to relative abundance of pores and to slight variations in color.

Parenchyma: In narrow inconspicuous circles about pores and in sometimes fine concentric lines apparently limiting growth rings.

[158] This name seems more properly applicable to *Melanoxylon*. See p. 256.

Pores: Very small, but usually visible on account of parenchyma, appearing somewhat lighter than background; numerous; fairly evenly distributed or slightly zonate; occurring singly or in small groups; open in sapwood; closed in heartwood.

Vessel lines: Fine and wavy; fairly distinct; darker than background.

Vessel contents: Tyloses abundant; often gummy.

Rays: Very fine; visible in sapwood, invisible or nearly so in heartwood on cross section; slightly undulating; invisible on tangential; visible, but inconspicuous, on radial surface, appearing of about the same color as the background.

Ripple marks: Absent.

Gum ducts: Present in some of the rays; visible as fine black dots on freshly cut tangential surface; not numerous.

Remarks: The woods of the various kinds of "quebracho colorado" are too much alike to permit specific distinction from known structural features. *S. balansae* is said to be preferred to *S. Lorentzii* for extract.

Material: Yale Nos. 532, 534, 900, 924, 952, 955, 1045, 1069*, 1072, 1073*, 1085, 1086, 1128, 1129, 1133, 3997, 3998 (Arg.); 3419*, 3438, 3443*, 4755 (Braz.). Asterisk indicates botanical material.

38. AQUIFOLIACEAE

The only genus of special interest in the Holly Family is *Ilex* (the holly), which contains over 200 species widely distributed in temperate and tropical regions over the world. Most of them are shrubs or small trees more valuable for decorative and special purposes than for their wood. The largest number of species occur in Brazil and Guiana.

The leaves of certain species, particularly *Ilex paraguensis* St. Hil., supply the "mate" or Paraguay tea, which is a highly important article of commerce and is to the people of southern South America what tea is to the Europeans. The center of the industry is in the state of Paraná, where the small trees are propagated under the open canopy of the Paraná pine (*Araucaria*).

The holly wood of commerce is typically hard, rather fine-textured, with rays as large as in sycamore (*Platanus*), though less conspicuous, and with a chalky-white or bluish-white color which gives it a special value in inlay work and marquetry. The microscopic features of the wood of *Ilex* are distinctive; the vessel perforations are scalariform with many bars, and the ground mass is composed of fiber-tracheids with spiral thickenings.

There is a species of *Ilex* in British Guiana known as "kakatara-balli," which, judging from a specimen of the wood, reaches rather large size. It is reported that logs are obtainable up to 30 feet in length and squaring 12 inches. Apparently the material is little used, the only

reported instance being for table drawers. The wood is inferior both in texture and color to the holly wood of commerce (*I. opaca* Ait.).

THE WOOD

Ilex sp. *Kakatara-balli.*

Common names: Kakatara-balli, kookerite-balli (?) (B. G.).

General properties: Color a fairly uniform dingy white; little distinction between heart and sapwood.

Odor and taste not distinctive.

Moderately hard and firm. Sp. gr. (air-dry) 0.80. Weight about 50 lbs. per cu. ft. Grain straight or fairly so. Texture medium. Wood easy to cut; not durable.

Growth rings: Absent or indistinct; sometimes indicated by somewhat darker bands without definite boundary line.

Parenchyma: In numerous, very fine, irregular lines, mostly invisible without lens; sometimes continuous for considerable distance, but usually very short and often extending only from one narrow ray to another.

Pores: Few and small, barely visible without lens; occurring singly or in short radial rows.

Vessel lines: Fine and indistinct.

Vessel contents: Apparently absent.

Rays: Of two kinds: (1) Extremely fine and scarcely visible with lens; (2) large and distinct on all sections and resembling *Platanus;* not very conspicuous because of lack of contrast with background; heterogeneous.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: This specimen is considerably harder and heavier than indicated by published descriptions of the wood, and has about the consistency of beech (*Fagus*). The wood of "pavier blanc" or "palétuvier blanc" of French Guiana, said to be *Ilex casiquiarensis* Loes., is of the same general structure, but is finer-textured and softer. (Material: Yale No. 5388; Bertin's No. 3029.)

Material: Yale No. 3043 (B. G.). Identification from wood structure, subsequently confirmed by Forestry Officer of British Guiana.

39. CELASTRACEAE

The Staff-tree Family consists of nearly 50 genera and upward of 400 species of trees, shrubs, and woody climbers, well distributed throughout both temperate and tropical regions of the world. They yield very few economic products. There are 12 genera in India, two or three of which contain large trees, but their timber is little used. The wood of some of the smaller trees is employed locally for carving, turnery, utensils, and combs. There are six genera and 24 species in For-

Gathering Mate Leaves in Paraná, Brazil.
(*Ilex paraguensis.*)

Photos by H. N. Whitford.

Drying Mate Leaves for Tea in Brazil.

mosa, but only *Euonymus pellucidifolia* Hay., which is much used for walking sticks, is of any value.

One of the best known members of this family is our common bittersweet, *Celastrus scandens* L. Many species of *Euonymus* are planted for decorative purposes; they are mostly shrubs, although our wahoo or burning bush, *E. atropurpureus* Jacq., and the European spindle tree, *E. europaeus* L., may attain tree size. Two other genera have small arborescent representatives in the United States, namely, *Gyminda Grisebachii* Sarg. and *Schaefferia frutescens* Jacq. The former, known as false boxwood, grows on some of the islands of southern Florida and in Cuba and Porto Rico; the other, called yellow wood or Florida boxwood, the "cabra" of Santo Domingo, is a low evergreen tree or shrub, with small leathery leaves suggesting *Buxus*, found on the Florida Keys and in the Bahamas, West Indies, Mexico, and northern South America. There is a species of *Elaeodendron* in California, but it is only a shrub; others occur in the West Indies, one of which is called olive wood in Jamaica, one called "piñipiñi" or "pinipiniche" in Cuba, and another known as "corcorron," "coscorron" or "guayarrote" in Porto Rico. A species in Tres Marias Islands, Mexico, is called "mano de león." *E. Roxburgii* W. & A. is said to be "a graceful tree with a pretty wood, which is used for cabinet work and picture frames," occurring throughout the greater part of India. There are two genera of more or less economic importance in South America, namely *Maytenus* and *Goupia*.

MAYTENUS

There are more than a hundred species of *Maytenus* well distributed over all of South America and portions of the West Indies. They are mostly shrubs, though some of them reach tree size. The wood of the "nazareno morado" of Cuba, *M. lineatus* Wr., is used sometimes by cabinetmakers. The "sombra de toro" of Argentina, *M. ilicifolia* Mart., is usually less than 20 feet high and 10 inches in diameter, but the wood is used locally in the shops for repairing furniture, vehicles, tools, and agricultural implements. The macerated leaves are used in veterinary medicine. Another species, *M. phyllanthoides* Benth., usually grows along sea beaches, submerged by high tide, in Mexico and Cuba and supplies fuel wood. The Mexican names are "aguabola," "manglé," "manglé aguabola," and "manglé dulce."

The "maitén," *M. Boaria* Mol., is a well-known tree in Patagonia, and in the forests of the Rio Negro reaches a height of 75 feet. In other parts of its range it is usually less than 30 feet high and 15 inches in diameter, and on the cattle ranges is browsed down to a shrub. The

animals are so fond of the leaves that they will break down fair-sized trees to reach them. The wood, which is firm and elastic and does not split badly, is rather highly esteemed locally in all kinds of carpentry work and for making implements. The common names are: Maitén, maytén, maitén grande (Arg., Chile); leña dura, naranjito, cancorosa, sombra de toro, yuki-rá, sal de Indias (Arg.).

The "carne d'anta" (flesh of the tapir), *M. obtusifolia* Mart., is a common tree of the coast forests of the Bahia region of Brazil, where it occurs scatteringly, averaging rarely more than one or two trees per acre over large areas. It attains a height of from 75 to 100 feet and has a cylindrical bole, two to five feet in diameter, with little taper and without buttresses. The sapwood is white, but the heart is bright rose when first cut, though gradually fading upon seasoning. The logs are free of defects and are readily sawn into lumber, but thin boards have a tendency to warp badly if improperly dried. The wood is not durable in contact with the ground, but finds many uses in rural carpentry and construction where not exposed. Material supplied by Mr. Curran to manufacturers in the United States has shown satisfactory working qualities, being especially well suited for turnery. "Tapir wood behaves in the lathe very much like 'peroba,' or our own hard maple, but turning with slightly more difficulty than the latter. It will turn thin well as indicated by the satisfactory mouthpiece produced. It exhibits a very slight tendency to champ on sharp cuts at right angles to the grain. There is insufficient evidence to choose between this wood and 'peroba' as to superiority for turning purposes, although 'peroba' seems to be slightly the better."[159]

THE WOOD

Maytenus obtusifolia Mart. *Carne d'Anta.*

Common names: Carne d'anta (Braz.); tapir wood.

General properties: Color pale rose or roseate-brown, with rather indistinct purplish layers; rather dull and faded-looking. Sapwood white or gray; one to two inches thick.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.82. Weight about 51 lbs. per cu. ft. Grain fairly straight to somewhat irregular. Texture about as fine as in red gum (*Liquidambar*). Wood very strong, fairly easy to work, finishes smoothly, is tough and strong; not durable in contact with the ground. Crushing strength parallel to grain, 7840 lbs. per sq. in. Modulus of elasticity (bending), 2,551,300 lbs. per sq. in.; fiber stress, 10,240 lbs. per sq. in.

[159] Babbitt, Will C.: Turnings from Brazilian woods, *Wood Turning* (Milwaukee), 16: 7: 18, Apr., 1923.

The material for these tests was supplied by Mr. Curran. The "peroba" referred to is a species of *Sweetia* (Leguminosae) and is described under that genus.

Growth rings: Distinct, due to narrow purplish layers; visible on all sections, particularly the tangential, where they sometimes form a rather conspicuous pattern.

Parenchyma: In concentric bands limiting growth rings.

Pores: Not visible without lens; numerous; well distributed; occurring singly or more often in radial rows; open.

Vessel lines: Very fine and indistinct.

Vessel contents: None observed.

Rays: Very fine; faintly visible on cross section; invisible on tangential; readily visible, but not conspicuous, on radial, appearing somewhat darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits minute, crowded. Rays heterogeneous; two to four cells wide and few to 50 cells high; often with dark gum contents; crystals present; pits into vessels minute, half-bordered, the parenchyma portion often extending over several in the vessel. Wood parenchyma is in concentric bands, three to five cells wide, filled with red gum. Wood fibers are very thick-walled, with bordered pits.

Material: Yale No. 4692* (Braz.). Asterisk indicates botanical material.

GOUPIA

This genus consists of two or three species apparently confined to the Guianas and northern Brazil. The "goupi" or "goupi jaune" of French Guiana, *Goupia tomentosa* Aubl., is said to be a small tree only 20 or 25 feet high, with a rather light-colored wood of no importance. *Goupia glabra* Aubl., however, is one of the tallest trees in the forest in the Guianas and the Amazon region. In the localities of its best development in British Guiana it is said to reach a height of 120 feet with a long trunk that will square 30 inches, while logs 60 feet long and 12 to 16 inches in diameter are common. When the trees are felled the stumps exude a gelatinous substance having a fetid odor. Writers do not agree concerning the quality and utility of the timber, some considering it of inferior grade while others rank it next to the "mora" (*Dimorphandra*). It is reported suitable for railway ties, paving blocks, construction, especially of exposed walls, and for furniture. The Indians in the savannas prefer this wood for their canoes, because of its resistance to splitting under long exposure in the hot sun. The "cupiúba"[160] of the Lower Amazon is a large timber tree with durable wood of good quality, though, in common with that of the other species, it has an offensive odor when freshly cut.

[160] According to Huber (*Bol. Mus. Goeldi,* 6:86), the "cupiúba" is a different species, which he named *Goupia paraënsis.* Ducke (*Arch. Jard. Bot. Rio de Janeiro,* 3:205) considers it, however, only a form of *G. glabra* Aubl.

THE WOOD

Goupia glabra Aubl. *Cupiúba.*

Common names: Cupiúba, cupiúva (Braz.); copie, copi, couepi, coupi, goupi, koepie, kopie, cabacalli, kabukalli, kaboekalli (Guianas).

General properties: Color light reddish-brown, deepening somewhat upon exposure; uniform, lusterless.

Odor very pronounced and disagreeable when fresh; much less pronounced in dry wood; suggests *Viburnum lentago* L. Taste disagreeable, but not very distinct in dry specimens.

Hard and heavy. Sp. gr. (air-dry) 0.82 to 0.88. Weight 51 to 55 lbs. per cu. ft. Grain variable from straight to more or less roey and irregular. Texture rather coarse. Wood rather harsh, fairly easy to cut, planes badly in cross-grained specimens; appears durable.

Growth rings: Present, but often indistinct; due to rather poorly defined poreless zones. Not limited by parenchyma.

Parenchyma: Invisible without lens and not always distinct with it; more or less diffuse, with tendency to form short, narrow, tangential lines from ray to ray.

Pores: Rather large and readily visible; numerous; well distributed except for narrow zones; mostly solitary; without definite arrangement; open.

Vessel lines: Distinct as deep scratches, long, or alternately long and short in specimens with ribbon grain. Vessel perforations are scalariform with comparatively few bars and are large enough to be seen with good hand lens.

Vessel contents: Vessels mostly open. Some gum deposits and occasionally distinct white deposits noted.

Rays: Very fine and numerous; bending around pores; barely visible without lens on cross section, appearing somewhat fuzzy under lens, due to parenchyma cells; invisible or nearly so on tangential; readily visible, but not conspicuous, on radial surface, being of same color as, or lighter than, background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels rarely in contact with one another; perforations scalariform with three to ten coarse bars. Rays decidedly heterogeneous; of two types: (1) Uniseriate and composed of vertically elongated cells, thus resembling parenchyma strands, and (2) multiseriate, with narrow procumbent cells (three to five seriate) mingled with coarse square or upright cells; pits into vessels very small and half-bordered. Wood parenchyma diffuse and sparingly developed about vessels; cells coarse and mostly square; pits into vessels half-bordered, the mouths often coalescing into spirals. Wood fibers in radial rows; very thick walled; abundantly pitted with large and distinctly bordered pits; cavities often filled with gum. For further details see Janssonius, H. H.: Mikrographie einiger technisch wichtigen Holzarten

aus Surinam, *Ver. d. k. Akad. v. Wettenschaffen te Amsterdam,* 18: 2: 1-50, Feb., 1914.

Material: Yale Nos. 3908, 3926 (Braz.); 4166, 4195 (Sur.); 5381 (Fr. G.); 5107, 5108 (B. G.); 6343* (Venez.). Asterisk indicates botanical material.

40. ICACINACEAE

This family, which some botanists include in the Olacaceae, consists of about 45 genera and 150 species of trees, shrubs, and woody vines, widely distributed throughout the tropics. One of the most interesting plants is the giant climber, *Phytocrene gigantea* Wall., of Burma, the stems of which, upon being cut, give out a quantity of fresh drinking water. One of the few timbers of value is the New South Wales maple, *Villaresia Moorei* F. v. M., a tall tree with a pale yellow wood with prominent rays giving it a distinct silver grain suggesting beech (*Fagus*).

There are about nine arborescent genera in tropical America, but little information is available concerning them. Apparently the only product of value is supplied by species of *Villaresia,* whose leaves are employed in southern Brazil, Paraguay, and Argentina as a substitute for the true "mate" (*Ilex*) to which the genus seems closely related. There are no important uses for any of the woods. The "umary," *Poraqueiba,* has a wood of a grayish-red color, rather hard and strong, and it is said to be utilized to a minor extent locally for interior construction, carpentry, and fuel. The fruit of this tree is edible and the pulp is rich in oil. *Calatola mollis* Standl. is a Mexican tree about 65 feet high, known as "nuez de calatola" or "calatolazno," while its spikes are called "colas de ratas." Its seeds have medicinal properties.

In the woods of this family, according to Solereder,[161] the vessels are characterized by scalariform perforations, exclusively or in part; the pits between parenchyma and vessels are all half-bordered or part half-bordered and part simple; and the wood fibers have bordered pits.

41. SAPINDACEAE

The Soapberry Family consists of about 120 genera and over a thousand species of trees, shrubs, and woody vines, widely distributed in tropical and warm regions, especially of the Old World. There are about 18 arborescent genera in tropical and sub-tropical America, some of them consisting of a single species, but the entire list does not include

[161] Solereder, H.: *Systematic anatomy of the dicotyledons,* Oxford, 1908, pp. 205-206.

any important timber trees,[162] though some of the woods are locally useful.

Taken as a whole, the woods vary in color from yellow to pinkish, red, or brown, and are hard and heavy, often extremely so, and of fine or medium texture. The rays are very fine and in some instances are scarcely distinct under the lens. Parenchyma is very sparingly developed as a rule, but in *Sapindus*, *Melicocca*, and *Magonia*, it is about the pores and in distinct tangential or concentric bands suggesting certain of the Leguminosae. The pores are usually rather few and arranged in short radial groups or rows. The wild China tree of the south central United States, *Sapindus marginatus* Willd., is conspicuously ring-porous like ash (*Fraxinus*), but the soapberry[163] of southern Florida and tropical America, *S. Saponaria* L., has few, widely scattered, small pores. Ripple marks are absent. Gum ducts of the gummosis type have been reported in *Dilodendron bipinnatum* Radlk. of Brazil. As to the minute anatomy: The vessels have simple perforations and the pits into the parenchyma cells are half-bordered. The pits of the wood fibers are simple.

42. RHAMNACEAE

The Buckthorn Family consists of about 50 genera and several hundred species of erect or climbing shrubs and small trees, often thorny, well distributed over the world in both temperate and tropical regions. Their timbers are not exported, but are sometimes of local importance for fuel and special purposes, particularly in places where other tree growth is not available. Their principal value is in the bark and roots and sometimes other portions of the plant as well, which have medicinal properties or yield dyestuffs and enter to some extent into the markets.

The woods exhibit considerable variation, but are mostly hard, heavy, and strong, and of fine texture. The colors represented include gray, various shades of brown, orange, and bright cardinal.

The family is well represented in America, and there are six arborescent genera in the United States, namely, *Condalia*, *Reynosia*, *Krugiodendron*, *Rhamnus*, *Ceanothus*, and *Colubrina*, all of which extend their range southward into the tropics. The European buckthorn, *Rhamnus cathartica* L., is a common hedge plant of northern Europe and eastern

[162] The maples (*Acer*) and the buckeyes and horse-chestnuts (*Aesculus*), sometimes included in the Sapindaceae, are considered as belonging to the families Aceraceae and Hippocastanaceae, respectively. Four species of maple occur in the mountains of Mexico, two of them being of the boxelder type and known as "arce" and "acecincle" or "acezuintle." They are not commercially important.

[163] The pulp of the fruit contains as much as 37 per cent of saponin and is much used in tropical America as a substitute for soap; hence the name, soapberry. The wood is little used except for fuel.

North America. *Krugiodendron ferreum* Urb. (= *Condalia ferrea* Gris.) is noted for being the heaviest wood in the United States, its specific gravity (oven-dry) being 1.3 (equal to about 81 pounds per cubic foot), according to the tests on 429 native woods for the Tenth Census. The "piquillin" of Argentina, *Condalia lineata* A. Gray, is a small tree with a very heavy, hard, durable wood of a lustrous flesh-red color, highly valued in turnery and cabinetwork.

CEANOTHUS

A familiar member of this genus is the so-called New Jersey tea, *Ceanothus americanus* L., a low shrub common in old pastures and along roadsides. Three species attain the dimensions of small trees in California, and have rather soft wood of no value.

More widely known is the cogwood, *Ceanothus Chloroxylon* Nees (= *Zizyphus Chloroxylon* Oliv.), which appears to be confined to the island of Jamaica, where it was originally very common in the interior mountain districts, attaining a height of from 30 to 60 feet with a short trunk rarely over a foot through. The sapwood is nearly white and composes the bulk of the stem until the trees get old; the heartwood is of a yellowish-green color. The wood is hard, sinks in water when dry, and is very tough and durable. It was formerly considered one of the most valuable woods in Jamaica and was highly esteemed and much in demand for the frames of sugar and coffee mills, and for the rollers and the cogs of wheels in the cane crushers. Its use is now very restricted, largely because of the scarcity of available timber. The common names of this species are: Cogwood, Jamaica cogwood, greenwood, Jamaica laurel, cerillo, Jamaica greenheart (Eng.); gelbes holz, grünes holz (Germ.); bois doux jaune, bois jaune, bois verdoyant, laurier bois jaune (Fr.); groenhout, groenhoutboom (Dutch).

COLUBRINA

A few of the 25 or more species of this genus occur in the Far East, but most of them are indigenous to tropical America with their northern limit in southern Florida. The "saguaragy" or "sobragy" of Brazil, *Colubrina rufa* Reiss., is a tree of medium height with a trunk 25 to 30 feet long and from two to three feet through. The wood is yellowish or light red with darker patches, fine-textured, very heavy, hard, and strong, difficult to cut, and highly durable. It is used in cabinetwork, vehicles, shipbuilding, bridges, and is considered a first-class timber for railway ties and fence posts.

The naked wood or soldier wood of southern Florida and the West

Indies, *C. reclinata* Brong., reaches a height of 50 to 60 feet with a trunk three or four feet in diameter, divided by numerous irregular deep furrows multiplying and spreading in all directions like a tangled mass of serpents and covered with a thin orange-brown bark, exfoliating like river birch (*Betula nigra* L.). The wood, which is yellowish-brown, heavy, hard, strong, fine-textured, and durable, is little used except for fuel and a few minor purposes. The common names are: Naked wood, soldier wood (Fla.); mabi, palo mabi (P. R.); smooth snakebark (Bah.); mawbee stick, bois costière, bijaguara (Trin.); West Indian greenheart, ironwood, snakewood (Eng.).

Colubrina ferruginosa Brong., which closely resembles the latter species, is found very commonly throughout the West Indies, but is said to attain its best development in Martinique, where it reaches a height of 75 feet and a diameter of two feet or more. Although the wood is of good quality and durable, its use seems to be limited to the rural districts, where it serves for general carpentry, construction, and fuel. The common names are: Snakebark, bitters, West Indian or Bahama snakewood, W. I. greenheart, ironwood (Engl.); schlangenbaum, westindisches eisenholz (Germ.); slangenboom (Dutch); bijaguara, birjagua (Cuba); abelluello, abejuelo, achiotillo, aguacatillo, aguaytarán, guitarán, quitarán, mabi, raton, sanguinaria (P. R.); bois conleuvre, bois de fer, bois de serpent, nerprun ferrugineaux (Mart.); chaquira, chaquiro, chaquirio (Boliv.); guayul, manzanita, pimiento-ché, yax-puken, yax-pukim (Mex.).

43. ELAEOCARPACEAE

This family, which some botanists include in the Tiliaceae, consists of 10 or 11 genera of trees and shrubs of wide distribution in tropical and sub-tropical regions of the southern hemisphere. Their timber or other products are of slight commercial importance. There are many species of *Elaeocarpus* in the Far East, "handsome trees with white flowers and fringed petals and with drupaceous fruit resembling an olive" (Gamble). Their light and soft to moderately heavy and hard woods range in color from white or grayish to yellowish-brown, sometimes with a greenish tinge. *Echinocarpus*, of the same general region, contains several species of large trees with yellowish-gray, moderately soft wood, in local demand for tea boxes, carpentry, and charcoal.

Of the three or four aborescent genera in the New World, the most commonly and widely distributed is *Sloanea*. The "motillo" or "cacáo motillo" of Porto Rico, *S. Berteriana* Choisy, occurs chiefly in the mountain forests and is said to reach a maximum height of 90 feet and a diameter of two feet, and has a very hard, heavy, strong, and durable

wood. The ironwood or break-axe of Jamaica, *S. jamaicensis* Hook. f., is confined to the interior portions of the West Indies, where it is said to attain its best development in the limestone hills. The tree grows from 70 to 100 feet tall and one to two feet in diameter, and the wood is so hard that it is very difficult for the natives to fell the trees. The name Sloane's greenheart has been applied to occasional small lots of the timber that have entered the trade. There are also several species in the Guianas and Brazil, apparently all small or medium-sized trees with hard reddish wood of little utility.

The "mameicillo colorado" of Panama, *S. megaphylla* Pittier, is a tree about 80 feet high and 16 inches in diameter, remarkable for its enormous leaves and fluted trunk in contrast with the same parts of *S. quadrivalvis* Seem., which also occurs there. The wood is of a light reddish-brown color, hard, heavy, and strong, straight-grained, fine-textured, taking a high polish. Growth rings are present and limited by a fine line of wood parenchyma; the latter is everywhere sparingly developed. The pores are small, not crowded, scattered singly or in short radial groups, sometimes closed. The rays vary in size from minute to rather wide and high and very distinct. The wood is said to have been used in Colon for the understructure of the old docks.

Common names of various species: Break-axe, ironwood, Sloane's greenheart, quebracho (Jam.); cacáo motillo, cacáo otillo, cacáo roseto, cacaillo, motillo (P. R.); quapolier, chataignier, chataignier de la Martinique (Fr. G.); chataignier franc, chataignier petit coco (Guad.); chataignier, chataignier coco (Mart.); oulougua-palou, goulougou-albani (Galibis); urucurana, sapopemba (Braz.); mameicillo colorado (Pan.); terciopelo (Salv.).

44. TILIACEAE

The Linden Family consists of 35 genera and about 400 species of trees, shrubs, and herbs. Herbaceous species of *Corchorus* are cultivated in the tropics as the source of a coarse and strong textile fiber, known as jute or gunny, which is an important article of commerce. Of the trees, the best known in the north temperate region is the basswood or linden, *Tilia*,[164] the source of highly valuable soft white lumber of great utility.

The woods exhibit a wide range of variation from a light, soft, spongy mass at one extreme to a hard, heavy, and strong material at the other, with numerous intermediate grades. The pores vary greatly in size, number, and distribution, but in general there is a tendency to the

[164] There are four species of *Tilia* in Mexico, where they are commonly known as "cirimo" or "sirimo," "tilo," and "yaca." They are not of commercial importance.

formation of short radial groups. Parenchyma is developed in varying abundance with a tendency toward irregular tangential lines, rarely visible without the lens, sometimes in a fine meshwork. The rays are often of two sizes, the larger distinct and sometimes conspicuous. Ripple marks are of common occurrence and are of two general kinds: (1) Where all elements are distinctly storied as in *Luehea*, *Diplodiscus*, and *Pentace*, and (2) where the larger rays are not storied or occupy two to several tiers as in *Grewia*, *Columbia*, and *Schoutenia*. In the second case the markings are often irregular and indistinct and may be seen more readily without the lens than with it. In some of the softer woods, notably *Heliocarpus*, it is common to find zones of unlignified cottony tissue, disposed either irregularly or concentrically.

APEIBA

The dozen or more species of trees and shrubs of this genus are confined principally to the northern half of South America. Huber[165] says that all the Amazon species of *Apeiba* are known by the name of "pente de macaco" (monkey comb) on account of their fruits, though he thinks they look more like a sea urchin than they do like a comb. The best known species is *A. Timbourbou* Aubl., which has a white, almost spongy wood of a peculiar laminated structure, suitable for rafts and other purposes requiring a material of light weight.

Although the Yale collections do not contain any authentic wood material of this genus, a specimen (No. 4063) obtained from a commercial lot of balsa, undoubtedly belongs here. It is white and has layers of variable width of fairly compact wood alternating with zones of unlignified cottony tissue which are sometimes an eighth of an inch thick. The pores are rather few and small, though readily visible, usually in short radial groups that are well distributed throughout both kinds of tissue. The rays are of two general sizes, only the larger being visible on cross section. Ripple marks are present only in the lignified tissue and are fairly distinct, though they are rather irregular, due largely to the fact that some of the higher rays occupy more than one tier. Parenchyma occurs in very irregular tangential lines, producing a coarse network, and also in rather widely spaced concentric lines; it is indistinct without a lens.

Common names of the various species of Apeiba are: Pente de macaco, peignes macaques, cortica, jangada (= raft), páo de jangada (Braz.); cabeza de negro, crizo, heriso, peine de mico (Venez.); malagano, corteza (Col.); peine de mico (C. A.); burillo (Nic.); tibourbou, petoumo (Galibis);

[165] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 191 (1909).

ivouyra (Garipons); bois calalou, bois de mèche, bois grège, bois banane, mahot chardon (Fr. G.); doro (B. G.); mahault chardon, tumbaol (Trin.).

LUEHEA

This genus embraces more than 25 species of trees and shrubs which are very common in tropical America, especially in Brazil. Best known and most widely distributed is *Luehea divaricata* Mart. of Argentina and Brazil, the wood of which is typical of the genus. This tree is a common component of the second-growth forests in the Bahia region. Mature trees of the virgin forest are 100 feet or more in height, with a diameter of 30 to 40 inches. The trunks are usually fluted. The bark is fibrous and the small branches are very tough, flexible, and whip-like, giving rise to some of the common names, *e.g.*, "azota caballo" (Span.) and "açoita-cavallo" (Port.), meaning horse-whip. Another Brazilian name is "estribeiro," a Portuguese word meaning master of the horse. The wood is used for interior construction of all kinds, carpentry, general furniture, woodenware, brush backs, clogs and shoe soles, chair seats, gunstocks, saddle frames, and pack saddles.

THE WOOD

Luehea divaricata Mart. *Açoita-cavallo.*

Common names: Açoita-cavallo, açoita-cavallo branco, soita-cavallo, salta-cavallo, açouta-cavallo, estribeiro, estribeira, estriveira, ivatingy (Braz.); azota caballo, sota caballo blanco, ivatingi, cabeti, Francisco Alverez, caá-o-veti-guazú (Arg.). Other species: Açoita-cavallo, etc., uacima do campo (Braz.); sota caballo colorado, sota caballo grande (Arg.); guácimo blanco (Venez.); malagano (Col.); guácimo, g. macho, g. molenillo, molenillo (C. R.); llalo (Guat.-Hond.); bonete, cabo de hacha, caulote, cotorrón, pataste, tepecaulote, terciopelo (Salv.); algodoncillo, chacah, kazcat, pataxte, pataxtillo, patazte, pepe cacáo (Mex.); guácima amarilla, varía, baría (Cuba).

General properties: Color grayish to light pinkish-brown, sometimes with lighter or darker streaks; luster medium to fairly high. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Moderately hard and heavy. Sp. gr. (air-dry) 0.60. Weight about 37 lbs. per cu. ft. Grain straight to finely roey. Texture medium. Wood easy to work, finishes smoothly; harder grades have about the consistency of beech (*Fagus*); does not appear durable.

Growth rings: Present, but not always distinct; due to slight differences in density or in color and sometimes to fine line of terminal parenchyma.

Parenchyma: In short tangential lines extending from ray to ray; very fine and irregularly disposed; not visible without lens; occasionally terminal; narrower than rays.

Pores: Small, but visible; numerous; fairly well distributed; occurring

singly or more often in compact radial rows of two to four, rarely more; open.

Vessel lines: Appearing as long inconspicuous scratches.

Vessel contents: None observed.

Rays: Fine, fairly visible on cross and tangential sections; distinct or fairly so on radial, being somewhat darker than background.

Ripple marks: Present; distinct; all elements storied, though some of the rays occasionally occupy more than one tier; number per inch, 65 to 75.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; without spirals. Rays decidedly heterogeneous; pits into vessels half-bordered. Wood fibers with numerous small pits, simple or indistinctly bordered.

Remarks: The "malagano" of Colombia and the "llalo" of Central America have fewer and somewhat larger pores and more distinct vessel lines. In a specimen (Yale No. 1723) from Argentina the ripple marks are less regular and distinct than in the others. The sp. gr. (air-dry) of various species tested varies from 0.55 to 0.67.

Material: Yale Nos. 3121, 3955*, 4689* (Braz.). Other species: Yale Nos. 1532*, 1571 (Col.); 1723 (Arg.); 3671* (Guat.-Hond.). Asterisk indicates botanical material.

HELIOCARPUS

Nearly all of the 20 or more known species of trees and shrubs of this genus are native to Mexico and Central America, with a few representatives extending as far south as Paraguay and Argentina and eastward into São Paulo, Brazil. The most widely distributed, apparently, is *H. americanus* L., a small or medium-sized tree, known by the curious name of "amor seco" in Argentina and as "jangada brava" in Brazil. The wood is used to a small extent for interior construction, boxes, and paper pulp. The bark yields a fiber sometimes employed for tying up tobacco and for cordage.

THE WOOD

Heliocarpus americanus L. *Amor seco.*

Common names: Amor seco, afata blanca, lapachillo (Arg.); jangada brava (Braz.). Other species: Majagüillo (Pan.); burío, burillo, burillo blanco (C. R.); burillo falso (Nic.); calagüe, calagua, calagual, mozote, mozotillo (Salv.); cahualagua, catena, coche, copal, cuahualagua, cuaulahuac, cuaulote, jolocín, jolocín blanco, jolotzín, jonote, majagua, majahua, quauhalagua, tolotzin, xolotzin, yaga-guiehi, zamo baboso (Mex.).

General properties: Color white or nearly so to somewhat brownish. Sapwood not clearly defined.

Without distinct odor or taste.

Very light, soft, and spongy. Grain fairly straight. Texture rather coarse. Wood rather stringy, with pith-like streaks which require very sharp tools to cut smoothly. Perishable.

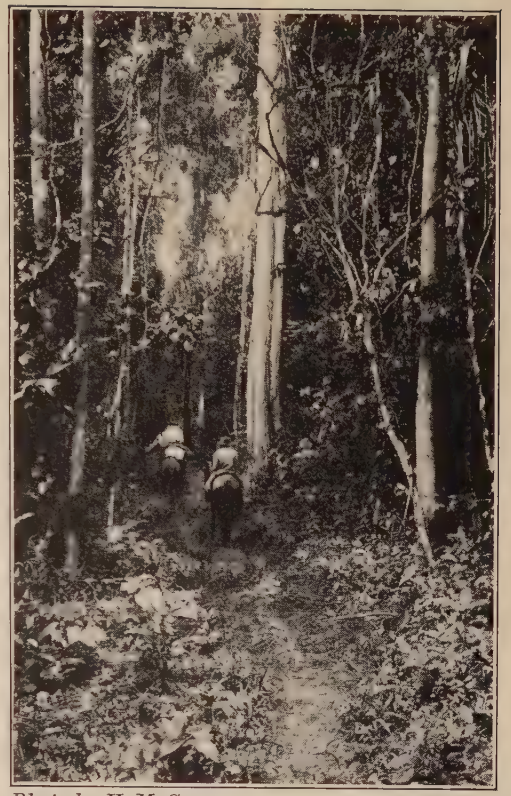


Photo by H. M. Curran.

Large Tree of Estrivera in Bahia, Brazil.

(*Luehea divaricata.*)

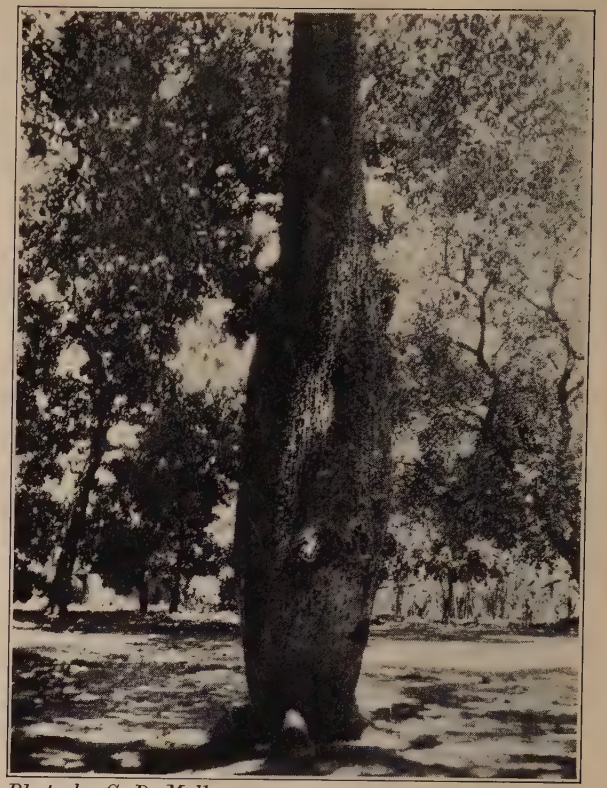


Photo by C. D. Mell.

The Barriguda Tree of Brazil.

(*Cavanillesia sp.*)

PLATE XLI

Growth rings: Absent or poorly defined. Presence of unlignified tissue sometimes suggests growth rings.

Parenchyma: Indistinctly about vessels. Unlignified cottony tissue usually present in bands or zones of irregular size and distribution, sometimes making up bulk of the wood, sometimes absent or only slightly developed.

Pores: Medium-sized; fairly distinct; few to fairly numerous; occurring singly or in radial groups of two or three; well distributed; open.

Vessel lines: Inconspicuous.

Vessel contents: None observed.

Rays: Variable in size; the larger usually fairly distinct on cross section; rarely visible on tangential; more or less prominent on radial surface.

Ripple marks: Present or absent; never very regular or distinct and less so under lens than without it; higher rays not storied; number of markings per inch, about 65.

Gum ducts: None observed.

Remarks: The woods of different species are much alike, particularly in their stringy character. Some of the softest material reminds one of corn-stalk pith.

Material: Yale Nos. 1709*, 2528, 3983 (Arg.). Other species: Yale Nos. 3007* (Pan.); 4350*, 4351*, 4360*, 4361* (C. R.). Asterisk indicates botanical material.

45. MALVACEAE

The Mallow Family consists of about 45 genera and upward of 1000 species of herbs, shrubs, and a few trees, with extensive distribution. The best known and most useful member is the cotton plant, *Gossypium.* Some of the herbs and shrubs are valuable for decorative planting, and the trees as a rule are more useful for their fibrous bark than for their timber.

THESPESIA

Of the 12 known species of this genus, mostly of the Far East, mention may be made of *Thespesia populnea* (L.) Corr., which occurs in the coastal forests of the Indo-Malayan region, tropical Africa, the West Indies, and certain other portions of tropical America. In Porto Rico it reaches a height from 30 to 60 feet in moist situations of the east and north coast. The inner bark of the branches and young stems yields a tough fiber which is used for cordage. The timber is little used here in America, but in the Far East is employed for furniture and cabinetwork, musical instruments, gunstocks, boats, and vehicles. The wood is of a dark brown or reddish-brown color, somewhat variegated, is rather hard and strong, often roe-grained, moderately fine-textured, works easily and takes a high polish, and is durable. The pores are small, but visible, not very numerous, scattered singly or in radial groups of two or three, sometimes with gummy contents. Parenchyma occurs

in exceedingly numerous minute lines, producing a network barely visible with the lens. The rays are fine, but distinct, on cross and radial sections, indistinct without lens on the tangential. Ripple marks are present; all elements storied; fairly regular; faintly visible; about 100 per inch. Vertical gum ducts of traumatic origin have been reported. *Material:* Yale No. 3880 from India.

Common names: Seaside mahoe, cork tree, Spanish cork (Bah.); emajaguilla, palo de jaqueca, santa maría (P. R.); majagua de Florida (Cuba); catalpa (Guad., Mart.); mahault de londres (Trin.); Portia tree, tulip tree (India); banálo (P. I.); fref, eijan (Gold Coast, Afr.); faux bois de rose, bois de rose d'Océanie (French); rosewood of Seychelles, umbrella-tree (Eng.).

Thespesia grandiflora DC. is a tree of general occurrence in Porto Rico, where it attains a height of 30 to 45 feet and a diameter up to three feet. The wood is of a rich chocolate-brown color, rather hard and heavy, of good cabinet qualities, and esteemed locally for furniture, musical instruments, and for construction purposes where strength and durability are essential. The common names are: Maga, magar, magas (P. R.).

HIBISCUS

This genus consists of upward of 200 species of herbs, shrubs, and trees, widely distributed. *Hibiscus tiliaceus* L. (= *H. elatus* DC. = *Paritium tiliaceum* St. Hil.) occurs along the seacoast throughout the tropics of the world, but is a small tree of little use except for the fiber of its bark. The wood is of a purplish color, somewhat variegated, and with a satiny luster. It is light and soft, but firm, having about the consistency of butternut (*Juglans cinerea* L.), is easy to work, takes a high polish, and is durable. The pores are small and barely visible, scattered singly and uniformly. Parenchyma is in fine circles about the pores, and in very numerous, extremely fine, short lines, producing a network not always visible with the lens. The rays are fine, visible on cross and radial sections, but requiring lens on the tangential, though sometimes faintly visible in sapwood. Ripple marks are present; all elements storied; fairly regular; visible; 85 to 90 per inch. No gum ducts observed. *Material:* Yale No. 2366 from the Philippines.

Common names:[166] Mahoe (Bah.); majagua or majahua (W. I., C. A., Mex.); emajazua (P. R.); seaside mahoe, mahault du bord de mer, mahagua del mar (Trin.); algodoncillo (Venez.); mahot, mahot blanc, mahot forestier

[166] Owing to the confusion of this species with *H. elatus* Sw., some of the West Indian names commonly ascribed to the former are omitted. Most of the vernacular names used in the Far East are also omitted.

(Fr. G.); mahot mahotière, mahot franc, marofranc (Guad.); maho, uacima da praia (Braz.); damajagua, emajagua (Peru); huamaga (Ec.); majagüito de playa (Col.); mojo (C. A.); majagua de playa (Pan.); holo, masahua, mazahua, xtolo (Mex.); malubago (P. I.); hau (Hawaii); fau (Samoa); fago (Guam).

The blue or mountain mahoe of the West Indies, *Hibiscus elatus* Sw. (= *Paritium elatum* G. Don), is fairly common throughout the Antilles and of unknown, though probably very limited, distribution on the Spanish Main. The tree makes its best development in the mountains of eastern Cuba, where it is conspicuous during the blossoming season on account of its clusters of rose-colored flowers. In very dry situations it is small and crooked, but in better sites it attains a height of 60 feet, with a long clear stem usually between 12 and 18 inches in diameter and occasionally much larger. Trees on the uplands are credited with producing wood that is harder, of deeper and more pleasing color, and of greater durability than that from moist land. This grade is sometimes sold as maltese wood. The wood is used for cabinetwork, both in solid and veneer form, interior finish, gunstocks, boats, vehicles, frames of agricultural implements, and for fishing rods. Nearly all of the readily accessible trees of the larger sizes have been cut, and it is only the large specimens which yield the high-grade product the trade demands. The inner bark yields a fiber, commonly known as Cuban bast, which is very pliable and highly durable. It is used extensively for making rope, hawsers, twine, sacking, mats, and by gardeners for tying plants and grafts. The fiber is secured by hewing off the outer bark while on the tree, followed by stripping off the inner layer and macerating it in water.

THE WOOD

Hibiscus elatus Sw. *Blue Mahoe.*

Common names: Blue mahoe, mountain mahoe, maltese wood, blue mahogany (Trade); majagua, majagua común, majagua blanca, majagua azul, majagua de la maestra (Cuba); emajagua, emajagua excelsa, majagua, mahagua (P. R.); tall hibiscus, grand mahot, bois de liege (Barb.); tulip tree.

General properties: Color bluish, greenish, or purplish, often with light and dark streaks; suggesting some specimens of tulip (*Liriodendron*); not highly lustrous. Sapwood nearly white.

Said to have a mildly fragrant scent when fresh, and to be more or less peppery when worked. No distinct odor or taste in dry specimens.

Moderately hard and heavy. Sp. gr. (air-dry) 0.65. Weight about 40 lbs. per cu. ft. Grain fairly straight. Texture rather coarse. Easy to work, of excellent cabinet qualities, resembling black walnut (*Juglans nigra* L.), strong and durable.

Growth rings: Absent or poorly defined; sometimes indicated by differences in density or in color.

Parenchyma: In narrow layer about pores; distinct only on moist cross section.

Pores: Medium-sized; readily visible; numerous; fairly well distributed; occurring singly or more often as though subdivided radially two to three times; open.

Vessel lines: Appearing as numerous deep scratches; of same color as background. Vessel segments very distinct under lens.

Vessel contents: None observed.

Rays: Fine, but visible, on cross and radial sections; not individually visible on tangential.

Ripple marks: Present, readily visible, fairly regular, all elements storied; number per inch, about 70.

Gum ducts: Vertical gum ducts in peripheral row and of traumatic origin observed.

Minute anatomy: Vessels with simple perforations; without spirals. Rays heterogeneous; mostly four cells wide and 10 cells high; pits into vessels small, half-bordered; wood fibers rather thick-walled; pits simple and inconspicuous.

Remarks: Is considerably harder, heavier, and stronger than *H. tiliaceus* and lacks the satiny luster.

Material: Yale No. 5008 (Cuba).

46. BOMBACACEAE

The Silk-cotton Tree Family, which some botanists consider a part of the Malvaceae, consists of 20 or more tropical genera of soft-wooded trees. Several of these are noted for their fast growth and for their massive and sometimes peculiarly swollen trunks. Certain kinds have their seeds imbedded in a silky cotton, the kapok of commerce, so extensively used for stuffing mattresses, pillows, cushions, and to a limited extent for textiles. The fibrous inner bark of some species is utilized locally in the manufacture of cordage and in clarifying sugar.

The wood varies from a spongy or pithy substance to a rather compact and firm material useful for boxes and common lumber. It is very sappy when green and is likely to rot or stain in seasoning unless kiln-dried. The usual color is very light yellowish, grayish or brownish—but in some cases it is a deep reddish-brown suggesting Spanish cedar (*Cedrela*). Parenchyma is commonly present in the form of extremely fine, wavy, tangential lines, suggesting those in the Anonaceae, only more numerous and less distinct. The rays are often high and conspicuous on radial surface. Ripple marks are present in some of the woods and provide a valuable diagnostic feature. Vertical gum canals resulting

from the breaking down of the tissue are frequently met with. The only timber now exported is the balsa (*Ochroma*).

Mr. Curran has submitted the following notes regarding the trees of this family in Brazil:

They are plentiful both in the dry inland country and in the heavy rain forests along the Atlantic coast and the overflow lands of the great rivers, especially in the Amazon drainage. There are numerous species of several allied genera, *Bombax, Pachira, Chorisia,* and *Ceiba,* which are practically the same in so far as their lumber is concerned. In the dry regions they are reported as growing gregariously over considerable areas, but I have found them only as scattered individuals, often of huge dimensions, in the mixed hardwood forests which characterize Brazil.

The typical tree is heavily buttressed and certain groups have very much swollen bottle-shaped bases, suggesting the baobab of Africa. A diameter of 10 feet, above the swollen base, is not uncommon and it is probable that individuals 15 feet through at this point could be found, while 30 or 40 feet through the buttresses is not exceptional. The trees reach a height of 150 feet or more with clear lengths of from 50 to 70 feet and a wide-spreading heavy-limbed crown. The young trees of certain species are armed with heavy, built-up, woody prickles, but the bark is usually smooth in the mature trees, though becoming rough with age. The wood is softer and lighter than pine and would make a very desirable cheap box and crating material. Its chief use at present is for the big dug-out cargo canoes employed on the great rivers. The logs are sometimes included as floaters in rafts of heavy woods. The cotton or kapok is collected in certain regions for use in pillows, mattresses, and cheap upholstery.

Huber[167] says that the woods of the Bombacaceae in the Amazon region are rarely used, although that of the "sumauma commum," *Ceiba pentandra* Gaertn., and the "sumauma do alto Amazonas," *C. Sumauma* Mart., may prove suitable for paper pulp. The wood of "mamorana," *Pachira aquatica* Aubl.,[168] is, according to his specimens, of more loose and porous structure. Other species mentioned as common are "munguba," *Bombax Munguba* Mart., the "cupuassurana," *Matisia paraënsis* Huber, and in the upper Amazon region the balsa, *Ochroma Lagopus* Sw., the trunks of which are used by the native Peruvians for rafts upon which they descend the tributaries of the Marañon to Iquitos.

There are two species of *Gyranthera* in Panama, Colombia, and Venezuela. The one in Venezuela is *G. caribensis* Pittier, known locally as "cucharón," "candelo," and "nono." It is said to be a tall tree with very light and spongy wood.

167 Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi,* 6: 191 (1909).

168 This species is a small or medium-sized tree very common along streams of northern Brazil and the Guianas, and also planted along streets.

BOMBAX, PACHIRA, AND BOMBACOPSIS

In its restricted sense, *Bombax* has pea-like seeds imbedded in silky wool or kapok, and the flowers appear when the tree is bare of leaves. *Pachira*, on the other hand, has edible chestnut-like seeds not imbedded in wool, and the flowers, which are large, appear along with the leaves and are usually hidden by them. A third genus, *Bombacopsis* Pittier,[169] is intermediate between the two in that the flower is a diminutive of *Pachira*, while the fruit resembles *Bombax*. Some botanists include all these forms in the single genus *Bombax*.

The available specimens of the woods of this tribe exhibit considerable variation, but the transitions between extremes are gradual and do not appear to represent generic distinctions. The most that can be attempted at present is to divide the *Bombax-Pachira* woods into two groups, namely, (1) the gray or *Ceiba*-like, and (2) the red or *Cedrela*-like.

CEIBA-LIKE WOODS

There are numerous species represented in this group, but there is not much information available concerning them. The "sibucara" of Venezuela is noted for the large size of the pear-shaped fruit pod which, according to Mr. O. Stelling of Caracas, is 14 inches long and often four inches in diameter at its lower and thicker portion. The seeds are small and numerous and imbedded in wool; the wood is light-colored and very strong and tough for its weight. The "pochote" of Central America has a similar wood, but the fruits are small.

One of the best known of this group in southern and eastern Brazil is the "imbirussú," credited to various species of *Bombax*, and closely resembling the "mahajua" of Colombia. It is taken as a type. It is said to be used for making canoes, coffins, boxes, molds, buoys, and paper pulp. The bark yields a fiber for cordage and calking, and the kapok is extensively employed for stuffing and upholstery.

THE WOOD

Bombax spp. *Imbirussú.*

Common names: Imbirussú, imbirassú, embirussú, imbira-guassú, imbira de folha (Braz.); palo blanco (Par.); pochte (Pan.); jilinsuche, pilinsuchil, shilo, shilo blanco (Salv.); sibucara (Venez.).

General properties: Color a dull or dingy brownish-gray, sometimes with a pinkish hue. Sapwood gray; not clearly defined.

Odor and taste absent or not distinctive.

[169] Pittier, Henry: New or noteworthy plants from Colombia and Central America, V, *Cont. U. S. Nat. Herb.*, 18: 4: 159-163 (1916).

Wood variable from light, soft, and spongy to rather firm. Sp. gr. (air-dry) 0.39. Weight about 24 lbs. per cu. ft. Grain straight or fairly so. Texture coarse, harsh. Wood fairly easy to work, but saws very woolly when fresh; does not take a smooth finish; is tough and strong for its weight; holds nails well; is not durable.

Growth rings: Fairly distinct to indistinct; due to dark lines.

Parenchyma: Invisible without lens and not very distinct with it; in very numerous, extremely fine, closely spaced, tangential or concentric lines interrupted by the rays.

Pores: Fairly large to small; distinct; not very numerous; well distributed; occurring singly, subdivided, or in groups.

Vessel lines: Distinct; sometimes rather oily; mostly long and straight.

Vessel contents: Occasional gum deposits.

Rays: Variable in size; only the larger visible on cross section and these often indistinct; mostly indistinct without lens on tangential, the lower ones storied, the higher occupying two to several stories; conspicuous on radial surface, appearing considerably darker than background.

Ripple marks: Present; of two kinds: (1) Visible to unaided eye, but not always distinct with lens, due mostly to low rays being in seriation; not very regular; about 40 or 45 per inch; (2) visible only with lens and four times as numerous as the others, due to the individual cells of the wood parenchyma strands (four per strand) being in horizontal seriation.

Gum ducts: Likely to occur traumatically; large and conspicuous, usually in a single vertical row with gummy contents.

Material: Yale Nos. 2504, 3156, 3243 from São Paulo; 4716 from Bahia, Brazil.

CEDRELA-LIKE WOODS

The *Cedrela*-like woods of this group are the "tolú" of Colombia, the "saqui-saqui" of Venezuela, and the "cedro espinoso" of Panama. The exact botanical status of these has not been determined, but according to Pittier the last two are *Bombacopsis*, the one from Panama being *Bombacopsis Fendleri* Pittier (= *Pachira Fendleri* Seem. = *Bombax Fendleri* Hemsl.). This is a deciduous tree, with a height up to 100 feet, with a slender prickly trunk, occurring as isolated specimens in the forest, and supplying lumber in limited quantity for general construction. The specimen in the Yale collections (No. 4312) is lighter-colored than those from Venezuela and Colombia, but it may be sapwood.

Mr. Curran supplies the following notes regarding the "tolu" of Colombia:

This is one of the very common timbers on the lower slopes in the northern part of the country, occupying the drier gravelly areas in a region of plentiful rainfall. It is associated with other trees of the Bombacaceae and also with *Cedrela*. It reaches a height of 100 feet, has a rather wide-spreading crown of heavy branches, and a somewhat irregular bole inclined to be but-

tressed and completely clothed with heavy prickles toward the base. It is deciduous and remains bare of leaves for many weeks. The fruits are dry capsules which upon bursting liberate a quantity of soft brown vegetable wool enclosing the small brown seeds.

In the regions where it is the principal species there are five or six of the trees to the acre with a yield sometimes of 4000 to 5000 board feet. It reaches the local market either in the form of squared logs or as whip-sawn lumber and is commonly met with in every carpentry shop of the coastal region. It has a soft texture, works readily with all machinery and tools, and is remarkable for the difficulty with which it gives up moisture, carpenters saying that it never becomes thoroughly dry in that humid climate. It is used chiefly for the manufacture of boxes and a substitute for cedar (*Cedrela*), and is frequently referred to as false cedar. The natives make large dugout canoes from the trunks. The same tree occurs, or at least is reported, in the Lake Maracaibo region of Venezuela, and the lumber is well known in all the local markets under the name of "saqui-saqui."

Pittier[170] says that the wood of the "saqui-saqui," which bears a general resemblance to Spanish cedar, contains a hygroscopic gum which keeps the material perpetually moist. If the lumber is kept submerged, preferably in running water, it is claimed that this gum will be dissolved out and the quality of the timber thereby greatly improved. The local uses of the wood include general construction and cooperage, especially tanning vats and rum storage vats. The timber has not been exported, but there is a possible market for it for the staves of water conduits.

THE WOOD

— *Bombacopsis* sp. *Saqui-saqui.*

Common names: Saqui-saqui, ceiba colorada, jaris (Venez.); ceiba, palo de seda (Curaçao); tolú (Col.); cedro espinoso (Pan.); cedro macho, aba, wild cedar (Nic.).

General properties: Color dull pinkish-brown to deep reddish-brown. Sapwood gray, rather sharply defined.

Without odor. Taste slightly bitter, not pleasant, not distinctive.

Light and soft, but firm. Sp. gr. (air-dry) 0.41 to 0.59. Weight 26 to 37 lbs. per cu. ft. Grain fairly straight. Texture rather coarse. Wood easy to work, finishes smoothly, has much the consistency of *Cedrela;* darker specimens appear durable.

Growth rings: Absent or indistinct.

Parenchyma: In very numerous, extremely fine, irregular lines, or network, barely visible with lens on moist cross section.

Pores: Resembling pin holes; fairly numerous, though variable in this respect; mostly in radial groups of few to several pores each; usually containing lustrous tyloses.

[170] Pittier, H.: *Esbozo de las formaciones vegetales de Venezuela,* Caracas, 1920, p. 28.

Vessel lines: Large and rather conspicuous.

Vessel contents: Tyloses fairly abundant; sometimes gummy.

Rays: Variable on cross section from fine and indistinct to rather coarse and fairly distinct; the high rays distinct and often conspicuous on radial.

Ripple marks: Present; low rays storied, high rays occupying two to several stories; visible with and without lens; from 60 to 65 per inch; secondary seriation absent or indistinct.

Gum ducts: Vertical ducts of gummosis type often present.

Remarks: There is considerable variation in the specimens covered by this description, particularly in the size of the rays and pores. That from Panama is the finest-textured.

Material: Yale Nos. 362, 441*, 4419, 6676 (Venez.); 2750*, 2878*, 2882* (Curaçao); 327, 503, 1616 (Col.); 4312 (Pan.). Asterisk indicates botanical material.

MISCELLANEOUS

Specimens of the woods of the Mexican species of *Bombax* and *Pachira* are not available for study and accordingly cannot be classified at present. The following information is from Standley's *Trees and shrubs of Mexico*, pp. 792-794: *Pachira macrocarpa* (Schl. & Cham.) Walp. is a large tree with rounded crown found in southern Mexico and Central America, usually along river banks. The common names are: Apompo, zapote reventador (Mex.); sapotón or zapatón (Guat., Salv.); pumpumjuche (Salv.). *P. aquatica* Aubl. is a large or small tree growing along streams in southern Mexico, Central and South America, and West Indies. Common names are: Zapote bobo, z. de agua (Mex.); provision tree (B. H.); castaño silvestre, ceibón de agua, c. de arroyo (Cuba); bosch cacáo (Sur.); castanha do Maranhão, mamorana, mongubeira (Braz.).

Bombax ellipticum H. B. K. of southern Mexico and Guatemala is a large unarmed tree noted for the beauty of its flowers. The common names are: Amapola, a. blanca, a. colorada, cabellos de ángel, ceiba, chicochuchi, chicochuchl, clavellina, coquito, disciplina, ilztamatl, jiquique, lele, pochote, pochotl, pongolote, tiata, titilamatl, xanacol, xcunchó, xihuicxan, xiloxochitl, yaco de la costa (Mex.); doncella (Guat.). *B. Palmeri* S. Wats. is a smaller tree known from Sonora to Jalisco. The common names are: Clavellina, c. de la barranca, cuajilote, guajilote (Mex.).

The species of *Ceiba*, *Pachira*, and *Bombax* have been much confused in Mexican literature and in botanical publications in general. The following Mexican names are reported for plants whose identity is doubtful, although they belong to one of these three genera: Escobetilla, kuyché, pitón, thura, tumbile, yaga-xeni.

CHORISIA

There are six known species of *Chorisia*, five in South America and one, *C. soluta* Smith, in Central America. This species was found on the shores of Lake Amatitlan, Guatemala, at an elevation of 3900 feet and is referred to by the discoverer as "a tree with a gigantic trunk and flat wide-spreading head of *Bombax Ceiba* L., and with digitate leaves" (*Bot. Gaz.*, 16:2). The "paineira" of southern Brazil and the "samohú" of Argentina, *C. speciosa* St. Hil., attains large dimensions, but the timber is little used except for boxes and the trunks for canoes. The wood is suitable for paper pulp. The "palo borracho" of Argentina, *C. insignis* H. B. K., is a bottle-shaped tree, sometimes called "palo botella," rarely found in the dense forest, but occurring singly or in small groups in the open. The wood has a specific gravity of 0.23 to 0.45. It is used for slack cooperage, boxes, small handles, and miscellaneous purposes requiring a soft material. Canoes made from the trunks are extremely durable in the water and highly resistant to the hard usage they get in service; they are said to last 30 years or more. The fiber of the bark is considered excellent for cordage. The cotton about the seeds is of sufficient length and strength to serve for textile purposes as well as for stuffing.

THE WOOD

Chorisia speciosa St. Hil. *Samohú.*

Common names: Samohú, samuhú, algodón, algodonero (Arg.); paineira (Braz.); OTHER SPECIES: Samohú, palo borracho, palo botella, yuchán, luchán, epigüe, painá (Arg.); barriguda (Braz.); lupuna (Peru).

General properties: Color dull ashy-gray or brownish. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Light and soft, but firm. Sp. gr. (air-dry) 0.44. Weight about 27 lbs. per cu. ft. Grain straight, texture rather coarse. Wood easy to work, takes a smooth finish, is tough and strong for its weight, poorly resistant to decay.

Growth rings: Fairly distinct; due to parenchyma.

Parenchyma: In rather heavy brown lines, usually of sufficient spacing to appear to limit growth rings; also in extremely fine and numerous lines producing a meshwork visible only with lens.

Pores: Resembling small pin holes; rather few and scattered; mostly subdivided; open.

Vessel lines: Very distinct; appearing darker than background.

Vessel contents: None observed.

Rays: Rather coarse, but not very distinct, on cross section; visible on tangential; very distinct on radial, appearing darker than background.

Ripple marks: Present, but irregular and indistinct; the fine secondary seriation of the parenchyma cells is fairly distinct under lens.

Gum ducts: None observed, but probably occur.

Remarks: Resembles the harder grades of "imbirussú" (*Bombax*), but is not woolly or harsh, has more distinct growth rings, and less distinct primary ripple marks.

Material: Yale No. 2134* (Arg.); 3943 "barriguda"[171] (Braz.). Asterisk indicates botanical material.

CEIBA (ERIODENDRON)

Of the various species of this genus the best known is the silk-cotton tree, *Ceiba pentandra* (L.) Gaertn. (= *Bombax pentandrum* L. = *Eriodendron anfractuosum* DC.), which is very common in the West Indies, northern South America, and the tropics of the Old World. It is a massive tree, often 80 to 100 feet high and sometimes much taller, with a heavily buttressed and often swollen trunk of large dimensions. It is characteristically a tree of the open, with a large coarse crown which in some cases may attain a spread of 150 feet. The branches and young trunks are prickly. The tree is deciduous and blossoms immediately after the shedding of the leaves. The seeds, which are packed in kapok or silk-cotton, are rather widely dispersed and find their best conditions for germination in old fields which are soon covered with the rapidly growing young trees.

The wood is heavy with moisture when freshly cut, but is very light, about 27 pounds per cubic foot, when dry. If seasoned in the log it is almost certain to discolor and is likely to rot. The wood is little used except for dugout canoes and rafts. Suggested uses are paper pulp, corestock for veneers, slack cooperage, packing cases and boxes, toys, and miscellaneous uses requiring a soft, easily worked wood. It cannot compete with balsa for purposes of buoyancy and insulation. It is doubtful if it is suited for matches.

Regarding a special use of the trunks of "sumauma" in the Amazon region, Spruce[172] says: "The softness and lightness of the wood render it suitable above all other trees for hollowing out the trunk into what are called 'cuchas' or floating casks, which, being filled with turtle oil or 'capivi' on the upper Amazon and securely calked, are floated down to the Barra do Rio Negro or Pará." Some of these had a capacity of over 2000 gallons.

171 See footnote, p. 421.

172 Spruce, Richard: *Notes of a botanist in the Amazon and Andes*, London, 1908, pp. 186-187.

THE WOOD

Ceiba pentandra (L.) Gaertn. ***Silk-cotton Tree.***

Common names: Silk-cotton tree, cotton tree, kapok tree, corkwood (B. W. I.); ceiba or ceibo (Span. Am., gen.); seiba (Cuba); fromager (Haiti); silk-cotton, kapok tree, kumaka (B. G.); kapokier, bois coton, cotonnier grand bois, fromager (Fr. G.); fromagier (Trin.); ceibo jabillo (Venez.); ceibón, poxot (Nic.); arbol de algodón, cabellos de angel, peem, piim, pitón, pochote, pochotl, pochotle, xiloxochitl (Mex.); sumauma commum, sumaumeira (Braz.); silk-cotton tree (Africa); white cotton tree (India); arbre à coton (Fr.); baumwollenbaum (Germ.). Other species: Ceiba or ceibo, mosmote, piim, pochote, pochotl, yaxche (Mex.); sumauma do alto Amazonas, sumaumeira (Braz.); samu-hú, samohú, barrigudo, palo borracho, mandiyu-ra, paineira (Arg.); toborochi (Boliv.).

General properties: Color pinkish-white to ashy-brown. Sapwood not clearly defined.

Odor and taste absent or indistinct.

Light and soft, but firm and tenacious. Sp. gr. (air-dry) 0.44. Weight about 27 lbs. per cu. ft. Grain often irregular. Texture coarse. Wood easy to cut, is tough and strong for its weight, has a rather harsh feel, but is not woolly like "imbirussú"; not durable; stains readily.

Growth rings: Distinct to indistinct.

Parenchyma: Occasionally in tangential bands apparently limiting growth rings; in fine meshwork visible only with lens.

Pores: Appearing as good-sized pinholes; numerous to abundant; mostly single, but sometimes subdivided; may be larger in early wood; open.

Vessel lines: Large, numerous, very distinct.

Vessel contents: None observed.

Rays: Of variable size; some coarse, but not always prominent on cross and tangential sections, as they seem to merge into the fibers; very distinct on radial surface.

Ripple marks: Present; the primary poorly defined and more distinct without lens; the secondary fairly distinct under lens, but irregular.

Gum ducts: None observed, but probably occur.

Remarks: Pores much more numerous than in other woods of this family. Wood also harder than most of the others.

Material: Yale Nos. 2045* (Cuba); 1540*, 1547* (Col.). Asterisk indicates botanical material.

CAVANILLESIA

There are at least three species of this genus in South and Central America. *Cavanillesia arborea* (W.) K. Sch. of Brazil is said to attain a height of 65 feet, with a trunk 15 feet in diameter. In the dry regions the bole becomes remarkably swollen in the middle portion and con-

A Silk-cotton Tree in Trinidad.
(*Ceiba pentandra.*)

Photo by H. Pittier.

The Bongo or Quipo of Panama.
(*Cavanillesia platanifolia.*)

PLATE XLII

stricted above and below, giving rise to the name "barriguda,"[173] a Portuguese word meaning pot-bellied. (Plate XLI.)

C. platanifolia H. B. K. is a stately tree of limited distribution in Panama and northwestern Colombia, attaining a height of 80 to 100 feet high and a diameter up to six feet. The bole is long and cylindrical, without buttresses, but commonly much swollen just above the ground, giving the tree a peculiar and interesting appearance. Even the trees in the open have clear trunks and the crown is always small, open, and seemingly out of proportion to the size of the tree. The scars where the side branches were shed are distinctly visible on the smooth, grayish-green bark.

Rowlee[174] says: "The strength of the trunks is principally in the thick fibrous bark. The wood is even lighter than balsa. It is so fragile, however, that it crushes more or less as the tree falls. It is homogeneous, but a large percentage of the wood is parenchyma. The wood is so porous that air can readily be forced through it longitudinally. The large trees appear to be of great age, but our surmise is that they are rapid growers and by no means as old as they look."

There are no important uses for the wood at present, though it has been suggested as a substitute for balsa (*Ochroma*) and as a paper-making material. The wood blue-stains and rots so quickly that the logs must be removed from the forest as soon as cut and stored in the open exposed to the wind to dry. The only local use is for dugout canoes.

THE WOOD

Cavanillesia platanifolia H. B. K. *Bongo.*

Common names: Bongo, quipo, hammatti (Pan.); macondo (Col.).

General properties: Color white or yellowish, without silky luster; often with brown streaks; subject to blue-stain. Sapwood not distinct.

Odor and taste absent or not distinctive.

Extremely light. Sp. gr. (air-dry) 0.10. Weight 6¼ lbs. per cu. ft. Grain straight. Texture coarse and harsh, not soft and silky as in *Ochroma*. Wood very soft, of pith-like consistency, weak, easily dented by squeezing between the fingers; brittle, requires sharp tools to cut smoothly; perishable.

Growth rings: Not very distinct; due to concentric zones of parenchyma.

Parenchyma: In rather widely spaced concentric lines and also in short indistinct tangential lines between.

[173] This name appears to be applied also to *Chorisia crispiflora* H. B. K., and one wood specimen of "barriguda" in the Yale collections (No. 3943) agrees closely with *Chorisia* sp. of Argentina, while another of the same name (No. 4713) is entirely different and closely resembles *Cavanillesia platanifolia* H. B. K. (Yale No. 4931).

[174] Rowlee, W. W.: Tropical trees with light-weight wood, *Journ. N. Y. Bot. Gard.*, 22:256:75-78, Apr., 1921.

Pores: Look like pin holes; scattered; fairly numerous; occurring singly or radially; subdivided two or three times; open.

Vessel lines: Coarse; sometimes very distinct, due to dark color.

Vessel contents: None observed; vessel walls sometimes appear gummy.

Rays: Rather coarse; very distinct on cross and radial sections; usually indistinct on the tangential; of same color as the background.

Ripple marks: The coarse, poorly lignified fibers have blunt ends and are often arranged with sufficient regularity to give a storied structure visible only under the lens.

Gum ducts: Large vertical gum ducts, due to breaking down of tissue, occur, resembling the "gum veins" in *Eucalyptus*.

Remarks: All of the cells of this wood are so coarse that they are individually distinct under the hand lens. The rays are decidedly heterogeneous. In a commercial specimen (Yale No. 4052) obtained under the name of ceiba wood the rays seem to have broken down or split apart in drying.

Material: Yale No. 4931, collected by Prof. W. W. Rowlee in Costa Rica.

QUARARIBEA (including MYRODIA)

The dozen or more species belonging to this genus are said to be mostly small trees and shrubs with a fleshy-fibrous, one- or two-seeded fruit. *Quararibea turbinata* (Sw.) Poir., with a range from central Brazil to the Antilles, attains a height of about 50 feet. *Q. guianensis* Aubl. of the Guianas and lower Amazon is said to be a shrub or small tree with large white flowers.

Sterile botanical material of the "moro" of northern Guatemala has been identified by the botanists of the Smithsonian Institution at Washington as *Quararibea* sp. This, according to the notes of Dr. Whitford, who collected it, is a small tree having a thin, smooth bark with gray patches, the inner bark yellow. The only known local use for the wood is for ox-yokes. The wood (Yale No. 3699) closely resembles that of the "boton" of Colombia (Yale No. 3967), sterile botanical material of which has been identified by the same authorities as *Q. guianensis* Aubl. Mr. Curran, who collected it, says that it is a small tree 40 to 50 feet high, suggesting beech (*Fagus*) or holly (*Ilex*), with a bole 12 to 20 inches in diameter covered throughout its length with small limbs which interfere with its use for lumber.

The "veroity" of Brazil has a wood that is almost identical with the "boton" of Colombia, but the tree is very tall and slender and often rises well above the rest of the forest. It reaches heights of 135 to 150 feet and possibly more, and diameters of three or four feet are not uncommon. The bark is thin and smooth and of a gray or greenish color. The bole is usually free of limbs for from 50 to 70 feet, and carries

its taper to the ultimate twigs so that the entire stem could be used as a mast or flagpole.

Of all the trees of the tropical forests with which I am acquainted [says Mr. Curran], this one approaches nearest in form to the slender, tapering conifers of the north temperate zone. It grows in the deep moist soils of the rain forest of northeastern Brazil, and is one of the indicators of good soil for chocolate planting. It is associated with the "araçá de agua" (*Terminalia*) and "páo d'alho" (*Gallesia*) and often forms the bulk of the stand over considerable areas.

The wood is not appreciated by the Brazilians, as it is not durable and tends to stain blue or black very soon after cutting. When properly dried, however, it makes a clear-white or ivory-white lumber resembling American holly (*Ilex opaca* Ait.). The U. S. trade is much interested in this wood and has tested its working qualities with satisfactory results. The one serious defect is the presence of numerous large worm holes rimmed with black which destroy the usefulness of the material where a good surface is required. How common this defect is in mature timber can only be determined by carefully grading the lumber from a number of trees. It will probably be found to cut as clear as the average American hardwood, since it is practically free from knots and other defects. If fabrication tests on a commercial scale prove as satisfactory as the preliminary tests, this timber should find a ready market as a substitute for holly, as it can be had in large sizes at reasonable cost. The wood is readily impregnated with creosote and should make satisfactory cross-ties, and the lower grades of lumber are well suited for box boards.

THE WOOD

Quararibea sp. (?) *Veroity.*

Common names: Veroity, veroiti (Braz.); moro (C. A.); boton (Col.); aspai ? (Venez.).

General properties: Color chalky-white or slightly yellowish; not highly lustrous; subject to blue-stain. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Rather hard and heavy. Sp. gr. (air-dry) 0.72. Weight about 45 lbs. per cu. ft. Grain straight. Texture medium. Wood tough and strong, easy to work, takes a smooth finish, is not durable when exposed.

Growth rings: Absent or very poorly defined.

Parenchyma: In exceedingly numerous, fine, tangential lines extending from ray to ray; not visible without lens and not very distinct with it.

Pores: Small, but visible; numerous, but not crowded; well distributed; occurring singly or more often radially subdivided two to several times; open.

Vessel lines: Inconspicuous.

Vessel contents: None observed.

Rays: Coarse and distinct on cross section; barely visible on tangential;

high and conspicuous in proper light on radial surface, though of same color as background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessel perforations simple; pits extremely small, the elongated mouths giving a striate appearance. Rays heterogeneous, cells of fairly uniform diameter, but varying greatly in length, often square; mostly eight to 15 cells wide and a great many cells high; pits into vessels small and half-bordered; crystals common. Fibers with very numerous, irregularly distributed pits with slit-like mouths extending beyond the narrow border.

Remarks: This wood appears to belong to the Sterculiaceae rather than to the Bombacaceae.

Material: Yale Nos. 1781*, 4707 (Braz.); 3699* (Guat.); 3967* (Col.). Asterisk indicates botanical material.

OCHROMA

This genus, of which nine species have been described, is widely distributed throughout tropical America. The trees are mostly large and yield the balsa wood of commerce, famed for its lightness. (Plate XLIII.) Rowlee[175] says:

The wood of the trees of the genus *Ochroma* is the most notable among light-weight woods. It is generally known in Spanish America as balsa, and that word has been transferred to and is in general use in the United States. Balsa is the Spanish word for raft, and it was applied to this tree because the Spanish colonists, when they migrated to the New World, found it in use by the natives for rafts. . . . This name was and still is largely confined to countries where the trees were so used, that is, Ecuador, Colombia, and Costa Rica. . . .

Balsa is a very common and conspicuous tree in tropical America. It is distinguished not only by its light soft wood, but also by its large simple leaves, large solitary flowers, and very conspicuous fruit, which is not unlike a cotton boll on a large scale. When the fruit is matured, and has not finally burst, it looks much like a rabbit's foot and presumably from this, the first species of *Ochroma* to be described received the specific name "lagopus."[176] When the fruit finally bursts and the mass of down falls to the earth, it suggests the fur of a rabbit. The seeds are enveloped in this fur and are disseminated by it. They resemble small grape seeds and, unlike cotton, the "down" is not firmly and permanently attached to the seeds. . . .

[175] Rowlee, W. W.: Synopsis of the genus *Ochroma*, with descriptions of new species, *Journ. Wash. Acad. Sci.*, 9: 6: 157 *et seq.*, Mch. 19, 1919.

[176] Before Professor Rowlee's revision of the genus, all of the species except *O. tomentosa* Willd. were included under the name of *O. Lagopus* Sw., a species which now, according to Rowlee, should be restricted to include only forms that grow in the West Indies.

The species of this genus most frequently occur in the lowlands and foothills, though rarely, if ever, where the soil is at all affected by brackish or salt water. They have not been discovered in the higher altitudes, that is, at more than 1000 meters above sea level.

Balsa is usually a second-growth tree, though it does occur as an isolated tree in the primeval forest. It appears promptly and abundantly where clearings have been made by natural agencies, such as floods and fires, and by human cultivation. In this respect it might properly be called a tree "weed." The natural seeding in some places produces such an abundance of young plants as to suggest weeds in a neglected garden. The tree's growth is very rapid. During the first five or six years of its life it may attain a trunk diameter of 60 to 75 cm., and an average increase in thickness of 12 or 13 cm. per year. It also grows very rapidly in height, often attaining under favorable conditions 16 or 20 meters in five or six years. This gives it a place among the most rapidly growing trees known, if indeed it is not the most rapid of all.

In the natural state, the wood is very perishable. One rarely sees the remains of trees of balsa in the tropical forests. They decay with apparently the same rapidity as a cotton fabric; the wood absorbs moisture readily and shrinks and warps badly. This is due undoubtedly to the feeble lignification of the cell walls and to the lack of aseptic properties such as the timber of oak and pine possesses.

These tendencies of balsa have been largely overcome by a light impregnation with a hot paraffine solution, which has for its object the removal of the moisture and the waterproofing of the cells. It is also claimed that the process makes the wood easier to work with tools and does not materially increase its weight. During the war large quantities of treated balsa were used in the manufacture of buoyancy and insulation products, such as life preservers, submarine mine floats, parts of lifeboats, hydroplane pontoons, streamlining of struts and braces in airplanes, and for refrigerators for which the open porous structure well adapts it.[177]

THE WOOD

Ochroma spp. *Balsa.*

Common names: Balsa, balsa wood (Trade; Ec., Peru, Col., C. R., Nic.); palo de balsa (Peru, Boliv.); tami (Boliv.); lano, balso (Col.); gatillo, polak, polach (Nic.); cajeto, moho, lana (Guat.); tanbor, lanillo (Guat.-Hond.); guano (Sp. Hond.); algodón (Salv.); lanillo, lanero, seibón botija (Cuba); corkwood, down tree, bombast mahoe, dum (Jam.); corcho, tacarigua, bois flot, corkwood, down tree, balsa wood (Trin.); bois flot, patte de lièvre (Mart.); bobwood, balsam (Misc.).

General properties: Color pinkish-white or pale reddish; sometimes brownish; with a rather silky luster. Sapwood usually not clearly defined.

177 For further information see Carpenter, R. C.: The properties of balsa wood (*Ochroma Lagopus*), *Trans. Am. Soc. Civ. Eng.*, 81: 125-160 (1917).

Odor and taste absent or not distinctive.

Lighter than cork and soft and spongy. Sp. gr. (oven-dry) 0.12 to 0.20. Weight 7½ to 12 lbs. per cu. ft. Young, quickly grown trees have the lightest wood; that produced later in life may be considerably denser. Grain straight. Texture coarse. Wood fairly easy to work, but requires sharp knife to cut smoothly across the grain; crushes readily, but is strong for its weight; is perishable when exposed to decay.

Growth rings: Absent or poorly defined.

Parenchyma: Not visible.

Pores: Resembling small pin holes; readily visible; not very numerous; scattered; occurring singly or as though subdivided radially two to several times; open.

Vessel lines: Appearing as long deep scratches mostly darker than background. Segments readily visible under lens.

Vessel contents: None observed. Walls often appear coated with gum.

Rays: Readily visible and often very distinct on cross section; usually distinct on tangential; rather high and sometimes very conspicuous on radial surface. The rays exhibit wide variation in different specimens of the same species and even from different portions of the same cross section of a log. Many of the cells square or upright; visible with lens.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Woods of all the species are very much alike and apparently do not exhibit greater variation than is the case within a species or even in various portions of a single old tree. *O. grandiflora* Rowlee and *O. limonensis* Rowlee have brownish instead of reddish or pinkish heartwood and in the Yale specimens (Nos. 4357, 4358) the sapwood is sharply defined. The wood of *O. velutina* Rowlee is harder and heavier than the others, according to Rowlee (*loc. cit.*, p. 165). *O. Lagopus* Sw. is the smallest tree of the genus.

Material: Yale Nos. 3688* (Guat.); 4356*, 4357*, 4358*, 4373*, 4374* (C. R.); 1819, 4439*, 4929*, 4930* (Ec.); 360 (Venez.); 2040 (Col.); 4054, 4055, 4056, 4057, 4060 (trade specimens). Asterisk indicates botanical material.

MISCELLANEOUS

Matisia, with about 10 species, occurs mostly in Colombia and the Guianas. *M. cordata* H. & B. is a tall tree of the tropical Andean region with large heart-shaped leaves, caulescent flowers, and fruits that are edible when green. *M. Castañon* T. & P. yields a kind of cocoa.

Bernouillia flammea Oliv., of limited distribution in southern Mexico and northern Central America, is a large tree, 100 to 125 feet high, resembling *Ceiba*. The deciduous leaves are digitate, with five or six leaflets, and the vermilion-colored flowers appear in the dry season before the advent of the new leaves. The fruit is a five-valved woody capsule about eight inches long, with smooth interior, and with grooves

and numerous indentations for the reception of the ascending winged seeds. The wood is soft and spongy. The tree is known in Oaxaca, Mexico, as "palo calabaza" and "palo de perdiz."

There are three known species of *Hampea,* their combined range extending from southern Mexico to northern South America. A specimen of *Hampea integerrima* Schlect. var. *appendiculata* (Yale No. 4365 collected by Professor Rowlee of Cornell University, with herbarium material; his No. 42) from Costa Rica, where it is known as "buriogre," is very light and soft with a velvety feel suggesting *Ochroma.* The principal distinction is that ripple marks are present, of a double series, one produced by the storied fibers and parenchyma strands. The parenchyma, as is generally the case in this family, is in very numerous, minute, tangential lines not visible without lens and not always distinct with it. The pores are small, but visible, being darker than the background, and are few and scattered. The rays are narrow, but rather high; visible on cross section, distinct but not conspicuous on the radial. Another specimen of "buriogre" (Yale No. 4367), from a sawmill in Costa Rica, is of much the same structure, but the wood is firmer, having about the consistency of a soft grade of white pine (*Pinus Strobus* L.). A Mexican species of *Hampea* is known as "jonote blanco" and "majagua."

47. STERCULIACEAE

The Cocoa Family consists of about 50 genera and over 700 species of herbs, shrubs, woody climbers, and trees scattered throughout the tropics and warm regions of the world. Its best and most widely known products are cocoa and chocolate, which are obtained from the seeds of the "cacáo," *Theobroma,* a small Brazilian tree now cultivated extensively there and in various other countries. There are eight or nine arborescent genera in tropical America, but they supply no timber of more than local utility.

Taken as a whole, the woods of this family have rather large pores; the rays vary from fine to rather broad, but are fairly high and conspicuous on radial surface; ripple marks are common, with only the low rays in seriation or with the higher ones occupying two to several tiers; parenchyma is developed in varying amounts, sometimes only about the pores and sometimes in very numerous and extremely fine lines usually invisible without lens, and sometimes in coarse lines that are very distinct. Vertical mucilage canals and gum ducts of traumatic origin have been noted in a number of species.[178]

[178] See Record, S. J.: Further notes on intercellular canals in dicotyledonous woods, *Journ. of Forestry,* 19:2:225-266, March, 1921.

THEOBROMA

There are about 20 known species of *Theobroma*, the "cacáo" or cocoa, in various parts of South America, particularly Brazil, and in Central America. There are now four great cocoa-producing regions of the world, namely, the African (the largest), the Caribbean and the Ecuadorean (producing the bulk of the high-priced product), and the Brazilian (particularly southern Bahia). The planted trees are short-boled, widespreading, and the plantations resemble apple orchards. The fruit is a small melon-like pod of a reddish or golden-yellow color, filled with large bean-like seeds from which cocoa and chocolate are manufactured. The principal species planted is *Theobroma Cacao* L. The wood is light and soft, but firm, with few pores, prominent rays, and with parenchyma in very numerous, very fine, tangential lines not visible without lens. It finds many local uses when the requirements are not exacting. The "cupuassú" of the Amazon region, *T. grandiflorum* Schum., attains a diameter of a foot or more and is said to have a light-colored wood that is fairly homogeneous and compact, but little used. The "cacáo del monte" of Panama, *T. Bernouillii* Pittier, attains a height of about 40 feet, with a straight trunk over a foot in diameter, which is made use of by the natives in building their houses.

GUAZUMA

This genus, with about 10 known species, is widely distributed throughout tropical America. The best known species is *Guazuma ulmifolia* Lam., which is credited with a range including the West Indies, the Guianas, Brazil, and Argentina. In Argentina, where it is commonly known as "camba-acá," it attains a height of 50 to 65 feet and a diameter from 20 to 28 inches, and supplies a pinkish wood, soft, but firm and tough, used to a limited extent in carpentry, joinery, and for tool handles. It is a common tree in Brazil, known there as "mutamba," and reaches its largest size in the Amazon region, where it occurs sparingly along the river banks. The wood is employed locally for interior construction, carpentry, and sometimes for gunstocks. The bark is used in refining sugar and also provides a fiber for cordage. In the West Indies, where it is commonly called "guácima," the tree attains a height of from 40 to 60 feet, with a trunk 15 to 24 inches through. It is often planted for shade near dwellings and along fences and is very common in the second-growth. The wood is tough and strong for its weight, and is used for slack cooperage, general carpentry, and for fuel and charcoal.

THE WOOD

Guazuma ulmifolia Lam. *Guácima.*

Common names: Guácima or guácimo (Sp. Am., gen.); West Indian elm, guazuma plum (B. W. I.); guácima boba (Cuba); bois d'orme, guazuma, Trinidad elm (Trin.); orme des Antilles, bois puant (Mart.); orme d'Amerique, cacaoyer à feuille d'orme (Fr. G.); guácimo macho (Venez.); mutamba (Braz.); camba-acá, cambeza de negro, ingá-hú, ingá-negro, marmelero (Arg.); guácimo colorado (Col.); guacimillo (Nic.); chicharrón, caulote (Salv.); cablote, caulote (Guat.); aquiche, bulines, cuahulote, cuaulote, majahua de toro, palote negro, pixoi, pixoy, tablote, vácima, yaco granadillo (Mex.).

General properties: Color light pinkish; sapwood not distinctive.

Odor and taste absent or not distinctive.

Rather light, but tough and strong. Grain fairly straight. Texture rather coarse. Fairly easy to work, does not split readily, has about the consistency of elm (*Ulmus*); not durable.

Growth rings: Indistinct to fairly distinct, due to differences in porosity and density.

Parenchyma: In exceedingly numerous minute lines, visible with lens on moist cross section and appearing as fine network.

Pores: Medium to very small; larger ones readily visible; larger and more numerous in early wood; mostly in radial groups or rows of few to several pores each; open.

Vessel lines: Appearing as inconspicuous scratches.

Vessel contents: None observed.

Rays: Many of them rather coarse; very distinct on cross section; indistinct on tangential; rather high and conspicuous on radial, giving a silver grain.

Ripple marks: Present, but irregular; indistinct; high rays not storied or occupying several tiers; number per inch, 75 to 80.

Gum ducts: None observed.

Remarks: The inner bark is in very thin laminations and is fibrous.

Material: Yale Nos. 1554, 1571 (Col.); 4581, 4648 (P. R.); 4807 (Haiti).

STERCULIA

This genus consists of about 200 known species of trees and shrubs occurring in the tropics of both hemispheres, with the largest representation in the Far East. Some of the trees are valuable as a source of strong and coarse bark-fiber used for cordage, heavy ropes, bagging, and occasionally rough clothing, and certain species are planted for decorative purposes. The woods are not of much value, being usually too soft and spongy for ordinary uses. Some are fibrous and fairly strong for their weight and are suitable for boxes, light construction, matches, and paper pulp; others are of pith-like consistency, and useful for articles of buoyancy and insulation if protected from decay.

THE WOOD

Sterculia sp. *Imbira Quiaba.*

Common names: Imbira quiaba (Braz.). Other species: Boia, unha d'anta, chicá, páo rei (Braz.); cacagüillo, cacagüito, cacaíto, camoruco, cumaruco (Venez.); camajonduro, camajurú (Col.); panamá, castaño (C. A.); bellota (Mex.); anacagüite (P. R.); bois caca, bois de caca, bois puant, bois de corne fétide, bois de merde, bois de cavalone (Fr. G.); doux petites feuilles (Guad.); tourou-tourou (Galibis).

General properties: Color pale yellow or brown; lustrous. Sapwood grayish or nearly white.

Odor and taste absent or not distinctive.

Very light and soft, but of considerable strength for its weight. Sp. gr. 0.25. Weight about 16 lbs. per cu. ft. Grain fairly straight. Texture coarse. Saws woolly, cuts easily with sharp knife, and presents a smooth, rather glossy surface; is not durable.

Parenchyma: About pores and in irregular concentric bands, sometimes doubled or tripled, and apparently limiting growth rings; visible without lens on moist cross section; also in extremely numerous fine lines producing a meshwork visible only with lens on moist cross section.

Pores: Look like pinholes; mostly solitary; rather few and scattered; tyloses present.

Vessel lines: Rather large; often darker than background.

Vessel contents: Tyloses present; vessel walls look gummy.

Rays: Coarse; distinct on all sections, especially the radial, where they are high and produce silver grain, though of about the same color as background.

Ripple marks: Present, but often irregular; faintly visible without lens; only fibers and parenchyma strands in seriation; in the parenchyma bands there is a secondary seriation of the cells of the strands.

Gum ducts: None observed, but may be expected since they have been found in other species.

Remarks: Wood suggests that of the Bombacaceae. The wood fibers are about 2 mm. in length.

Material: Yale No. 4681 collected in Bahia, Brazil, with sterile herbarium material by Mr. Curran.

48. DILLENIACEAE

Many of the plants of this tropical family have showy flowers and are of more value for decorative purposes than as sources of timber. There are five genera in the Indo-Malayan region which contain trees, but species of *Dillenia* are the only ones of large size. About 15 species are native to the Philippine Islands, and the woods, known in the Manila market without distinction as "catmon," are used to a limited extent for interior finish, flooring, and general construction, and also for furni-

ture and cabinetwork. The only arborescent genus in tropical America is *Curatella*.

The woods of this family have many features in common. They are hard and heavy or moderately so, of a reddish to brick-red color, and durable; the rays are large and conspicuous as in the Proteaceae. The vessel perforations are either exclusively scalariform with many bars or in part simple and in part scalariform with few bars; the ground mass of the wood is composed of fiber-tracheids with distinctly bordered pits.

CURATELLA

Of the three or four species of this genus, the one best known and most widely distributed is *Curatella americana* L. It is found in northern and eastern Brazil, the Guianas, Venezuela, Colombia, Central America, southern Mexico, and portions of the West Indies, and is for the most part a small, crooked tree of the savannas, rarely attaining a height of 30 feet and a diameter of 12 inches, and owing to the poor timber form is not of commercial importance. The wood is employed locally for various purposes such as fuel, charcoal, fence posts, and in a small way for cabinetwork. The leaves, in common with those of *Dillenia*, are large and tough and contain so much silica that they are used locally as a substitute for sandpaper. The bark is sometimes utilized for tanning and for medicinal purposes.

THE WOOD

Curatella americana L. *Rough-leaf Tree.*

Common names: Rough-leaf tree (Eng.); chaparro (Sp. Am., gen.); hoja-man, raspa-viejo, tlachicón (Mex.); lengua de vaca, malcajaco (Salv.); chumico de palo, hoja-chigüe, raspa-guacal, r. del árbor (C. R.); chumico, c. palo, curatela (Pan.); peralejo (Col.); curata (Venez.); bâtard (Cay.); parica, feuille rude (Fr. G.); curatahie (Guianas); careicillo, vaca-buey (Cuba); caimbahiba, caimbé, cajueiro bravo, cambaiba, sambahiba, sambai-binha, sobro (Braz.).

General properties: Color brown or reddish-brown; variegated on account of prominent rays; sapwood not very clearly defined.

Odor and taste not distinctive.

Rather hard and heavy. Sp. gr. (air-dry) 0.77. Weight about 48 lbs. per cu. ft. Grain interwoven. Texture coarse. Wood hard to cut and to plane; durable.

Growth rings: Apparently absent.

Parenchyma: In numerous very fine lines, scarcely visible even with lens.

Pores: Rather large and distinct; few; scattered; occurring singly.

Vessel lines: Indistinct.

Vessel contents: None observed.

Rays: Very large and conspicuous; wavy; making up bulk of the wood; producing pronounced "silver grain"; some white substance present in cells and visible with lens; strands of fibers bend around rays on tangential surface.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Differs from woods of the Proteaceae in that the pores are few and scattered instead of being in tangential lines, the wood parenchyma is not visible without a lens, and under compound microscope some of the vessels are seen to have scalariform perforations and the fibers have distinctly bordered pits.

Material: Yale Nos. 814 (Cuba); 1484, 3433* (Braz.). Asterisk indicates botanical material.

49. EUCRYPHIACEAE

This family (sometimes included in the Rosaceae) consists of one genus, *Eucryphia*, with six known species, of which two are Australian, three Chilian, and one Patagonian. *E. Billardieri* Spach., the leatherwood of Tasmania, varies in size from a bushy shrub to a very large tree, with snowy white flowers and yielding a hard, tough, fine-textured wood of a very pale chocolate color, suitable for cabinetwork and heavy construction.

E. patagonica Speg., called "huinque" in Neuquen, Argentina, is a tree about 50 feet high and 16 inches in diameter, with a moderately hard, fine-textured, durable wood of excellent quality for the carpenter's use. *E. cordifolia* Cav., the "ulmo" of southern Chile, is a large and important timber tree in the southern part of that country. Simmons[179] says: "In blossom the 'ulmo' is the dogwood of Chile. The spring brings forth prolific bloom of large white flowers, which present an aspect of rare beauty. The wood of the tree, strong, very close-grained, hard, and not difficult to work, makes excellent flooring, which is its most exacting use in southern Chile. It is abundant south of the present principal lumbering region, and is therefore not common on the markets. 'Ulmo' is not durable exposed, but in the nitrate region, where there is no rain, it is in demand, and because it is not given to checking, is preferred to 'roble pellin' (*Fagus obliqua* Mirb.) for cross-ties and telegraph poles. The Indians seek large 'ulmo' trees for making the best dugout canoes." Other uses given (*loc. cit.*, p. 18) are furniture, vehicle parts, yokes, oars, and piling. The bark contains about 15 per cent of tannin and is used for the manufacture of extract for commercial tanning. The flowers are rich in nectar and are an excellent source of honey.

[179] Simmons, Roger E.: *Lumber markets of the west and north coasts of South America*, Spl. Agts. Ser. No. 117, Bu. For. and Dom. Com., Washington, D. C., 1916, p. 20.

THE WOOD

Eucryphia cordifolia Cav. *Ulmo.*

Common names: Ulmo (Chile). Other species: Huinke, huinque (Arg.); leatherwood (Tasmania).

General properties: Lustrous pale chocolate-brown with a reddish tinge; somewhat variegated. Sapwood not present in specimens studied.

Odor and taste absent or not distinctive.

Of medium hardness and weight. Sp. gr. (air-dry) 0.63. Weight about 39 lbs. per cu. ft. Grain straight or nearly so. Texture fine and uniform, suggesting red gum (*Liquidambar*). Wood easy to work, takes a smooth and lustrous finish, is strong and tough, appears fairly durable.

Growth rings: Present; due to narrow layer of denser late wood; distinct on longitudinal section and producing figured effect on tangential surface of lumber.

Parenchyma: Scanty; diffuse; not visible.

Pores: Very small; not visible without lens; abundant, especially in early wood; usually not in contact with one another; no special arrangement.

Vessel lines: Very fine and indistinct.

Vessel contents: None observed.

Rays: Invisible without lens on cross and tangential sections; fine, but distinct, on radial surface, appearing darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The minute anatomy of this wood is distinctive. The vessels have scalariform perforations with many bars; the inter-vascular pits have a tendency to scalariform, while those into the parenchyma are large, simple to half-bordered, with a tendency to scalariform arrangement. The rays are of two kinds, uniseriate, and triseriate in middle portion, all filled with reddish gum and decidedly heterogeneous. The ground mass of the wood is composed of fiber-tracheids, with numerous distinct pits with large round borders and narrow lenticular mouths which may extend beyond the border and often cross X-like. The parenchyma cells are few, scattered among the fibers, and filled with gum.

Material: Yale No. 4932, supplied by American Vice-Consul S. R. Thompson of Valparaiso, Chile.

50. OCHNACEAE

This family consists of 18 genera and about 250 species of trees and shrubs, rather widely distributed in the tropics. The only species of present commercial importance occur in western Africa, the best known being *Lophora procera* A. Chev., a large tree, sometimes making up the bulk of the stand, and supplying a hard, heavy, durable, dark red wood exported as African oak or red ironwood. There are several arborescent genera in tropical America, but they do not supply timber for export.

CESPEDESIA

Cespedesia macrophylla Seem. is a beautiful tree, about 65 feet high and up to two feet in diameter, with coarse limbs and flattened umbrella-like crown, growing gregariously on the hillsides in eastern Panama, and presenting a gorgeous aspect at time of flowering. The very large leathery leaves and the inflorescences are all massed at the ends of the stout branchlets, and under this heavy crown the bare skeleton of the tree has an awkward appearance.

The wood, which appears to be typical of the family, is deep reddish-brown with somewhat lighter-colored sapwood, and is without distinctive odor and taste. It is rather hard and heavy, somewhat cross-grained, medium-textured, tough, strong, and probably durable. Growth rings are poorly defined, though sometimes indicated by color variations. Parenchyma is sparingly developed, occurring only as narrow circles about the pores, and is not visible with the lens. The pores are of medium size, fairly distinct, numerous, well distributed, and occur singly or are sometimes subdivided radially. Some of the vessels are filled with a white substance which shows distinctly on all sections. The rays are of two general sizes, the larger ones being fairly distinct on cross section while the smaller require the aid of a lens. Ripple marks are absent, and gum ducts were not observed.

The vessels have simple perforations; the pits are exceedingly small and numerous, their mouths coalescing into spiral-like striations. The rays are heterogeneous, one to eight cells wide and few to many cells high; and pits into the vessels are very small, numerous and half-bordered. The slender fibers have thick walls, very narrow cavities, and minute simple pits, and are usually arranged in radial rows. Dark red gum is commonly present in all cells.

There are no known uses of this timber. It appears suitable for railway ties, piling, and miscellaneous purposes requiring a strong and durable material.

Material: Yale No. 3002 collected by Dr. Pittier in Panama; his No. 4340.

51. THEACEAE

The Tea Family is widely distributed throughout the tropical regions of the world, but the trees, excepting those of *Caryocar*, are mostly small and of little or no importance for their timber. The best known member of the family is the tea plant (*Thea*).

CARYOCAR

Of the 16 species of this genus, nine are credited to Brazil, five to Guiana, one to Colombia and Venezuela, and one to Peru. Some of these

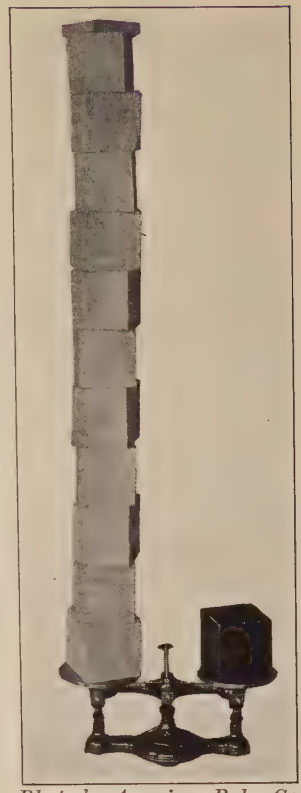


Photo by American Balsa Co.

Extremes of Density in Tropical Woods: Balsa and Quebracho.

(Ochroma and Schinopsis.)

Photo by H. M. Curran.

The Piquia, One of the Largest Trees in the Coastal Forests of Brazil.

(Caryocar brasiliense.)

PLATE XLIII

are large trees yielding useful woods and edible nuts that are an article of trade. According to the forestry officer of British Guiana, the nuts of *Caryocar tomentosum* Willd., known there as the sawarri nuts, or butternuts, are among the best in the world, but they are little known outside the colony. The oil expressed from the nuts is highly esteemed in northeastern Brazil for culinary purposes.

The sawarri tree is said to be fairly plentiful in some districts in British Guiana, where logs 70 feet long squaring 24 inches are obtainable. The wood is heavy (specific gravity 0.94 to 1.00), hard, tough, cross-grained, planes with difficulty, but takes a good polish and is durable. The color is uniform grayish-brown, and the odor is like that of sour vinegar. The timber is considered excellent for shipbuilding, mill timbers and planks, and has been suggested for piling.[180]

According to Pereira,[181] the "pequiá brava," *Caryocar brasiliense* St. Hil., grows in the north and west portions of the state of São Paulo, and has very twisted and crooked trunks from 18 to 25 feet long and from 16 to 20 inches in diameter. The wood, which is easily worked, is useful in shipbuilding, cabinetwork, turnery, scaffolding, and for cross-ties and other uses where exposed to dampness. It is described as of a uniform light satin-yellow color and of fine and straight grain, but apparently he has made the common mistake of confusing this with another wood of that region known as "pequiá" (*Aspidosperma*), belonging to an entirely different family (Apocynaceae) and having essentially different properties.

Huber[182] says that the "piquiá-eté" or "piquiá," *Caryocar villosum* Pers., is one of the most important woods in the Amazon region. It is a large tree scattered throughout the upland forests of that region and supplies a wood which, though porous, is very strong and tough on account of its interlaced fibers. It is valued especially for frames, knees, and floor timbers of ships and boats. It is used also for hubs and felloes of wheels, piling, posts, cross-ties, cooperage, and miscellaneous civil and naval construction. According to the same authority, the "piquiá-rana," *C. glabrum* Pers., yields a wood of lighter color, tending to yellow.

THE WOOD

Caryocar villosum Pers. (probably) *Piquiá.*

Common names: Piquiá, piquiá-eté, pequi, pequiá (Amaz., Braz.). OTHER SPECIES: Piquiá-rana, piquiá, pequiá brava, pequiá (Braz.); sawarri, souari,

180 HOHENKERK, L. S.: British Guiana timbers, *Journ. Bd. Agr. of Br. Guiana,* 12:3:175, July, 1919.

181 PEREIRA, HUASCAR: *The timber trees of the state of São Paulo,* Brazil, p. 65.

182 HUBER, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi.,* 6:192 (1909).

pekia, butternut tree (Br. G.); pekea, pekia, peki, pequi, pequy, chavarie, chawari, schwari, bois Marie, bois Mary, bois de tatayouba, bois de tatajuba (Fr. G.); saouary, saouarou, soeri, ningre notto, zeephout (Sur.); almendron (Col.).

General properties: Color dull grayish-brown; somewhat variable; not distinctive; has slightly oily appearance. Sapwood lighter; not sharply defined.

Taste not distinctive. Odor like vinegar; mild.

Hard and heavy to moderately so. Sp. gr. (air-dry) 0.81. Weight about 51 lbs. per cu. ft. Grain irregular, roey, much interwoven. Texture rather coarse. Wood fairly easy to cut; takes good polish; appears durable. Finished material has waxy feel.

Growth rings: Indistinct to distinct; due to darker zones nearly free of parenchyma and to certain parenchyma lines more regular and pronounced than others. Considerable variation in different specimens and different portions of same piece.

Parenchyma: Cells very numerous and fine; distribution variable from fine irregular network not distinct without lens, but imparting a dull or hoary appearance, to more or less definite and distinct zones and concentric lines. Not distinct on longitudinal surfaces.

Pores: Rather numerous and fairly uniform in size except within the groups, which are readily visible, though not large; solitary or more often in radial groups; distribution of groups fairly even, with some tendency to diagonal arrangement.

Vessel lines: Distinct, but not always conspicuous; in alternate bands of long and short lines, due to roe grain.

Vessel contents: Fine froth-like tyloses abundant. Some small dark green specks sometimes present.

Rays: Very fine and very numerous; at limit of vision on cross section; invisible on tangential and not distinct under lens; visible, but inconspicuous, on radial, appearing somewhat lighter than background.

Ripple marks: Absent.

Gum ducts: None observed.

Material: Yale Nos. 3935, 4096 (Amazon region, Brazil). Other species: Yale No. 5377 (Fr. G.).

52. GUTTIFERAE

This family consists of about 40 genera and 1000 species of trees, shrubs, and a few herbaceous plants, widely distributed throughout the tropics of the world. They are characterized by opposite and entire leaves and resinous sap. Some of the trees are useful for decorative purposes, while others produce fruits, oils, and resins of value medicinally and industrially; comparatively few of them supply valuable timber. Although the woods exhibit great variation in structure and properties, they are mostly hard or moderately so, with relatively few

medium-sized pores and distinct rays, while the parenchyma is usually in concentric lines or bands that are sometimes conspicuous. Resin ducts have been observed in the rays of *Mammea* and *Rheedia*.

MAMMEA

This genus consists of several species in tropical America and Africa, the best known being the mamey or mammee apple, *Mammea americana* L., a West Indian tree now widely cultivated throughout the tropics for its succulent fruit. It is a beautiful, medium-sized tree, rarely 60 feet high, with an oval crown of dense, dark green foliage. The trunk, which is rarely 24 inches in diameter, usually divides not far from the ground into several vertical or only slightly diverging limbs which bear small opposite branches. The bark supplies a gum resin of medicinal value and the timber is used locally for posts, piling, fuel, and, to some extent, for general construction.

The wood is red or reddish-brown, hard, heavy, specific gravity about 0.90, weight about 56 lbs. per cu. ft., strong and durable. Growth rings are poorly defined; the parenchyma is in numerous fine, short, tangential lines scarcely visible with the lens. The pores are small, but visible, rather few and scattered. The rays are fine, scarcely visible on cross sections and inconspicuous on the radial; some of them contain large resin ducts readily visible without lens. The ray cells are large enough to be seen with a lens on radial section and many are square or upright. *Material:* Yale Nos. 2702, 4664 (P. R.).

Common names: Mamey (Sp. Am., gen.); mammee, mammee apple, mammy apple (B. W. I.); mamey de Santo Domingo (Cuba); mamme sapote, abricotier (Trin.); abricot de Saint Dominique, abricot du pays, abricotier d'Amerique, abricotier des Antilles (Fr. W. I.); abricó do Pará (Braz.); mamey de Cartagena (Pan.); rurí (Nic.); zapote mamey, z. de Santo Domingo, z. Domingo, z. niño (Mex.).

CLUSIA

This genus contains a large number of species, mostly epiphytic shrubs. The best known is *Clusia rosea* Jacq., of interest chiefly because of its fig-like habit of usually starting as an epiphyte on other trees which it finally overgrows and strangles, itself becoming a tree sometimes 60 feet high and 24 inches in diameter. The wood, which is hard, heavy, compact, strong, and of a reddish-brown color, often with lighter or darker streaks, is used for fuel and fence posts. The vessels, which are few and scattered, have scalariform bordered pits and simple per-

forations. The rays are visible and composed mostly of square cells, one to three cells wide and many high, thick-walled, and abundantly pitted; the pits into the vessels are large, simple to somewhat bordered, often elongated laterally. The fibers are in radial rows, many with gelatinous layer; pits simple or indistinctly bordered. Parenchyma is scantily developed about the pores. *Material:* Yale Nos. 2689, 4525 (P. R.).

Common names: Balsam fig, balsam tree, pitch apple, West Indian gamboge (B. W. I.); cupey, palo de cupey (P. R.); copey (Cuba); figuier maudit, bois roi (Fr. G.); aralee, matapale, arali matepalo (Trin.); copey, cupay (Venez.); cape grande (Col.). Other species: Cupeillo (P. R.); paletuvier montagne (Guad.); parcouri-mani, parcouri-goupi, bois serpent (Fr. G.); kupé, kufa (B. C.); pérépéré, votomite (Galibis); gaque, cape, chagualo, capecillo oloroso, rampacho, tampacho (Col.); azahar de monte (C. R.); chunup, palo de aguila, zapatillo (Mex.); criuba, manga da praia, mata-páo, panapary, páo gamelo (Braz.).

RHEEDIA

Numerous species of *Rheedia* occur in tropical America and a few in Africa. The "guayabacoa" or "sebucán" of Porto Rico, *R. portoricensis* Urb., is a seacoast tree 10 to 60 feet high, with a wood resembling *Clusia rosea*. The "pacuri" of Brazil and Argentina, *R. brasiliensis* Pl. & Tr., is a tree about 35 feet high and 20 inches in diameter, with an edible fruit and yielding a rosy-yellow, resinous wood that is very hard, heavy, and strong, and used for handles and turned articles. The Amazonian "bacury-pary," *R. macrophylla* Pl. & Tr., has a medicinal bark and the wood is used locally for dimension timbers, general construction, and carpentry. *R. edulis* Pl. & Tr. is a forest tree, sometimes 100 feet high, occurring from Colombia to Guatemala. It is known as "sastra" in Panama, "jorco" in Costa Rica, and "chaparrón" in Salvador. Other species supply edible fruits, which are sold on the market in Colombia under the name of "madroño."

The "manaju" of Cuba, *Rheedia aristata* Gris., is a common, though not abundant, tree sometimes 16 to 18 inches in diameter, with a very hard, heavy, strong wood of a rosy-yellow color, sometimes mottled with red, used for rural construction and in the round form for posts and railway ties. In the only specimen available (Yale No. 807), the identity of which is not certain, the pores are few and small; parenchyma is developed in abundance in very numerous, irregular, wavy bands which include the pores; the rays are heterogeneous, five or six cells wide, distinct on cross and radial sections; some of them contain large resin ducts, as in *Mammea*. The vessels have very small pits and the apertures

coalesce into fine spiral striations; where in contact with parenchyma, a single pit is often elongated in the parenchyma cell to cover two to four in the vessel. The wood resembles in many ways that of *Garcinia* of the Indo-Malay region.

CALOPHYLLUM

There are about 100 species of this genus, mostly in tropical Asia and Africa, a few in tropical America. Many of the trees are small, but some of them are large and valuable for their timber; all have beautiful flowers and lustrous dark green foliage. The bark yields a balsam of some commercial value and the seeds supply an oil used locally for medicine and for illuminating purposes. Best known of the species of the Far East is the "poon"[183] of India and the "palo maría" of the Philippines, *Calophyllum inophyllum* L., an exceedingly tough, pinkish-red wood highly valued in shipbuilding.

The six known species in tropical America have a combined range covering the West Indies, and from northern Brazil through Central America into Mexico. *Calophyllum Rekoi* Standley is a tree 65 to 80 feet high of common occurrence in Oaxaca, Mexico, where it is known as "cimarrón" or "cedro cimarrón." A yellow sticky sap, resembling chicle, exudes from the wounded bark and is used by the Indians. It is also a common tree in the mountains of Salvador and is much planted for shade. The wood (Yale No. 4766; Reko's No. 3557) is of a pinkish-red color, rather light, but moderately hard, of good quality, and highly appreciated locally. *C. chiapense* Standley occurs in Chiapas, Mexico, where it is known as "leche de maría." The wood is used locally for making cart wheels.

The "jacareúba" of the Amazon region, *C. brasiliense* Camb., is utilized chiefly for bridge construction. In Santa Catharina it is called "guanandy" and is used for carpentry, construction, and furniture. The resin of the bark is medicinal and the seeds are rich in oil which is expressed for industrial purposes.

In the Guianas, there are two woods, namely, the "eda-balli" or wild calabash and the "kurahara" or "kurahura," which presumably are referable to this genus, since both have the typical structure and appearance, though differing in the size and distinctness of the parenchyma layers. "Kurahara" is a large, symmetrical tree growing on sandy soil and along the edges of swamps. The wood is used for making canoes and boats and is suitable for furniture and general carpentry.

The "santa maría," *Calophyllum Calaba* Jacq., is a lofty evergreen

[183] A small shipment of this timber entered the New York market in 1922 under the name of pear wood.

tree, sometimes well over 100 feet high and more than three feet in diameter, ranging from southern Mexico through Central America and northern South America to the West Indies. In Porto Rico it is common in moist sites and is also planted for decorative purposes. The timber is used for carpentry work, house and ship construction, furniture, wheel stock, and fence posts. The natives make dugout canoes from the large trunks. The seeds yield an oil used for illuminating purposes.

This tree is known as "ocuje" in Cuba. Neville[184] says: "The 'ocuje' is a tree found in all parts of Cuba, often in the high land forest, but more frequently along the banks and in the valleys of streams, growing right down to the water's edge. The tree becomes very large in favorable localities, and, differing in this respect from nearly all other hardwoods of Cuba, it survives the felling of the forest around it, continuing to live in its isolation, and, therefore, frequently occurs where no other timber still exists. The bark is corrugated, is a dark greenish black and is quite thick, and underneath it is found in moderate-sized trees from one to two inches of sapwood, beneath which the heart, varying in color from pink to a deep red, depending upon the age and rapidity of growth of the tree, is found. The trees are usually sound and solid, the wood is light in weight, retains its pinkish to red color when dry, is of rather open grain, but is extremely tough and elastic. It, therefore, is used very extensively in the manufacture of cart and wagon beds and tongues, the shafts for carriages, as also very frequently for the spokes of wheels. Where obtainable with ease it is frequently used for the main frames of buildings. In fact, it is used wherever strength and lightness are necessary."

The timber is fairly well known to the export trade, most of the present supply originating in southern Mexico and Central America, where the trees seem to make their best development. Since the wood has a reddish color it is often mixed in shipments of mahogany (*Swietenia*). Boulger[185] says it is "pale red to orange-yellow, moderately heavy and hard, clean, fine and straight in grain, flexible, with few knots, shrinking and splitting very little in seasoning, easily worked, durable. It has been used in our dockyards for beams and planks, and is equal to plain mahogany for interior finish."

THE WOOD

Calophyllum Calaba Jacq. *Santa María.*

Common names: Santa maría, chijole mahogany (Trade); marias, palo de

[184] Neville, H. O.: Hardwoods in Cuba, *The Cuba Review*, 18: 1: 23, Dec., 1919.
[185] Boulger, G. S.: *Wood*, London, 1908, p. 269.

maría (P. R.); ocuje (Cuba); baría, varílla, maría, santa maría (S. D.); galba, galpa, galopa, aceito de maría, crabwood (Trin.); maría (Venez.); aceite, aceite de maría (Col.); santa maría, calaba (Pan.); maría (C. R.); santa maría, krassa (Nic.); maría, santa maría, palo maría, limoncillo de cordóba (Mex.). Other species: Kurahara, kurahura, eda-balli, wild calabash (B. G.); penoga (Sur.); jacareúba, guanandy, guanandi, Brazilian mahogany (Braz.); balsamaria (Boliv.); arbol de maría, chagualo (Col.); cimarrón, cedro cimarrón, leche de maría (Mex.); marío, barillo, varillo (Salv.).

General properties: Color pinkish to brick red, usually showing fine dark striping due to parenchyma; rather dull. Sapwood lighter, clearly, but not sharply, defined.

Odor and taste absent or not distinctive.

Moderately hard and heavy; sp. gr. (air-dry) 0.68 to 0.74. Weight 43 to 46 lbs. per cu. ft. Grain fairly straight to irregular. Texture medium. Wood fairly easy to work, somewhat harsh, takes a smooth finish; is tough and strong; dark specimens durable; resistant to insects.

Growth rings: Absent or indistinct; sometimes slightly darker lines of wood parenchyma appear as limiting growth rings.

Parenchyma: In concentric or broken tangential lines mostly independent of pores; irregular; unevenly spaced; not distinct on cross section without lens; may be distinct on longitudinal, appearing darker than background, and producing irregular pattern on tangential surface. Pith flecks sometimes present.

Pores: Small to medium; visible; fairly numerous; arranged in irregular groups or diagonal chains; rounded.

Vessel lines: Distinct; darker than background.

Vessel contents: Tyloses rather abundant.

Rays: Very fine; not visible on cross section without lens; faintly visible on tangential; fine, but distinct, on radial surface, being darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; surrounded by small vessels and vascular tracheids; pits small, rounded, "screwhead" type, with sieve-like perforations. Rays mostly uniseriate, one to 30 cells high, heterogeneous, abundantly pitted, gummy; pits into vessels large, simple, often elongated vertically. Parenchyma cells large, in bands few to several cells wide, independent of pores. Fibers in radial rows, often flattened radially, some with gummy contents; pits with slit-like mouths and indistinct round borders.

Remarks: The wood of *C. Rekoi* (Yale No. 4766) is considerably lighter and softer than the available specimens of *C. Calaba,* and the pores are rather few and large.

Material: Yale Nos. 371 (Trin.); 3691*, 3691A*, 3703* (Guat.-Hond.);

6632 (Hond.); 2584 (Col.); 5009 (Cuba); 5025 (S. D.). Asterisk indicates botanical material.

PLATONIA

Only two species of this genus have been described, of which the best known is *Platonia insignis* Mart., of Brazil and the Guianas. Huber[186] says: "The representatives of the family Guttiferae are easily recognized on account of their opposite leaves, without stipules, and by a yellow emulsioned resin which exists in the new tissues and in the bark. The largest Amazonian tree belonging to this family is the 'bacury,' *Platonia insignis* Mart. It appears limited to the terra firma of the eastern part of the Amazon, to the State of Pará, being also distributed over a large part of central Brazil. Its dense and strong wood was formerly much used in civil construction, according to report."

In French Guiana, according to Bertin,[187] this tree, called "'parcouri," attains a maximum height of about 90 feet with a long clear trunk 32 inches in diameter. The bark is rich in latex which flows out of wounds and coagulates in quantity on the ends of logs. The wood has a specific gravity of about 0.70, is easy to work, of good quality, and suitable for carpentry, cabinetwork, furniture, interior and exterior construction, and shipbuilding. Two kinds of timber are recognized, the "parcouri soufre" and the "parcouri jaune," the difference being in the color rather than in the quality of the material.

In British Guiana, the tree is said to be scattered and scarce in Demerara, but plentiful in Essequibo, where it attains its best development in loose sandy soil, attaining an average height of 80 feet with a trunk upward of four feet in diameter. The fruit, which is of about the size and color of a large orange, is succulent and edible, and is called wild mammee apple. The heartwood of mature trees is very durable, takes a high polish, and is suitable for furniture. Its principal local use is for the frames of houses.

THE WOOD

Platonia insignis Mart. *Bacury.*

Common names: Bacury (Braz.); pakoeli, bacury, geelhart (Sur.); parcouri, parcouri jaune, parcouri soufre, bacury, manil (Fr. G.); pakuri, pakoorie, wild mammee apple (B. G.); matazama (Ec.).

General properties: Color yellowish-brown, with thin laminations of lighter and darker color (parenchyma and fiber layers); not highly lustrous. Sapwood gray; rather sharply defined.

Without distinct odor or taste.

[186] Huber, J.: Mattas e madeiras amazonicas. *Bol. Mus. Goeldi*, 6: 192-193 (1909).

[187] Bertin, A.: Les bois de la Guyane française et du Brésil, *Miss. For. Col.* V, Paris, 1920, pp. 126-128.

Rather hard and heavy. Sp. gr. (air-dry) 0.86. Weight about 54 lbs. per cu. ft. Grain straight. Texture rather fine, but uneven on account of laminated structure. Wood fairly easy to work, fissile, takes a good polish, is tough and strong, appears to season without difficulty; looks durable.

Growth rings: Distinct to indistinct; due to wider spacing of parenchyma lines or to more orderly arrangement of elements.

Parenchyma: In numerous closely spaced concentric bands, uniform or wavy, including the pores in part; from one-third to three-fourths as wide as the fiber layers; very distinct on all sections, appearing lighter than background, producing distinct figure on tangential surface, somewhat resembling fine-grained hard pine.

Pores: Medium sized; visible, but not very distinct; rather few and scattered; occurring singly or often subdivided radially two to several times; partially included in parenchyma; mostly closed with tyloses.

Vessel lines: Few; not conspicuous.

Vessel contents: Tyloses abundant.

Rays: Faintly visible on cross section; invisible on tangential; inconspicuous on radial surface; mostly two to three cells wide and 15 to 20 cells high; nearly homogeneous.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: This wood resembles certain of the Leguminosae. For minute anatomy see Janssonius, H. H.: Mikrographie einiger technisch wichtigen holzarten aus Surinam, *Ver. Kon. Akad. v. Wetensc. te Amsterdam,* 2d sec., 18: 2: 11-16.

Material: Yale No. 4019 (Braz.); 4181 (Sur.); 1824 (Ec.).

SYMPHONIA

The dozen or more species comprising this genus have their center of distribution in Madagascar, with one species, *Symphonia globulifera* L.f., extending to tropical America. This is a large tree occurring from the West Indies to Central America. In British Guiana it attains an average height of 100 feet in the forest, with long clear trunks up to 30 inches in diameter. In Panama it is sometimes 135 feet high in the forests of the low humid regions, with a straight trunk, upward of four feet in diameter, with low flat buttresses. The largest trees are usually hollow. The fruit is edible. The bark is rich in resin which is of a clear yellow color when fresh, but blackens upon exposure to the air; it is used by the Indians for calking boats and for impregnating cotton cord for torches. The wood, which is hard, strong, and durable, is used to small extent for general construction and carpentry. It deserves a trial for railway ties. Occasional logs have been shipped into the United States from Jamaica under the name of boar wood.

THE WOOD

Symphonia globulifera L. f. *Hog Gum.*

Common names: Hog gum, doctor gum, boar wood (B. W. I.); mannibalh, karimanni, buck-wax tree (B. G.); bois cochon, maní, manil (Fr. G.); anany, oanani (Braz.); maní, peraman (Venez.); cerillo, sambogum (Pan., C. R.); barillo (Guat.-Hond.).

General properties: Color greenish-brown; lustrous in proper light. Sapwood gray; sharply defined.

Odor and taste absent or not distinctive.

Wood rather hard and heavy, somewhat variable. Sp. gr. (air-dry), 0.66 to 0.70. Weight 41 to 43 lbs. per cu. ft. Grain fairly straight. Texture coarse. Wood somewhat harsh and splintery, not difficult to work, finishes fairly well; heartwood appears durable.

Growth rings: Poorly defined.

Parenchyma: In very numerous concentric bands, often wavy and irregular; usually including the pores; mostly from one-fourth to one-half as wide as the fiber layers; distinct on cross section, but inconspicuous on longitudinal surfaces because of lack of color contrast; yellow substance sometimes present.

Pores: Appearing as small pinholes; rather few and scattered; occurring singly or subdivided radially two to several times; partially included in parenchyma bands; closed in heartwood.

Vessel lines: Appearing as coarse, inconspicuous scratches.

Vessel contents: Tyloses abundant; yellow substance sometimes present.

Rays: Readily visible on cross section; faintly visible on tangential; very distinct on radial surface, producing silver grain, though of about the same color as the background; one to five cells wide and upward of 100 high; nearly homogeneous.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Readily distinguished from *Platonia* by its coarser texture and the higher and much more distinct rays.

Material: Yale No. 2971*, 6743 (Pan.); 3702* (Guat.-Hond.); 2725 (Jam.); 5386 (Fr. G.). Asterisk indicates botanical material.

MISCELLANEOUS

The "páo de S. José," *Killmeyera coriacea* Mart., grows in southern and eastern Brazil and supplies a resin of local utility. The "malva do campo" of the same region, *K. speciosa* St. Hil., is a small tree with heavy corky twigs and supplies some wood for interior building purposes and for fuel.

Haproclathra paniculata Benth. of northern Brazil is said to yield a beautiful red wood known as "muirapiranga." There is considerable

doubt as to the correctness of this statement, since the wood commonly referred to under this name belongs to the Moraceae.

The genus *Caraipa*, sometimes referred to the family Theaceae, contains several species in the Amazon forests, some of which are large trees commonly known as "tamacoaré" or "tamaquaré." *C. insidiosa* B. R. is called "inambuquissáua." The woods are said to be rather hard and heavy, specific gravity 0.69 to 0.79, and of local utility for general construction and carpentry, where not exposed to decay. A medicinal oil or balsam is obtained from incisions into the heartwood of the living tree; the sap of the bark and sapwood is said to be so caustic as to blister the skin.

There are many species of *Vismia*[188] in tropical America, one of which is known in Brazil as "caopiá" and others there as "páo de lacre," referring to the gum-resin of the bark. They are mostly small trees of some local utility, principally for fuel. Of the two wood specimens available, one (Yale No. 2892) is of *Vismia Hamani* Blake of the Venezuelan coast, where it is known as "lancitollo," and the other (Yale No. 1517) is the "punta de lanza" of Colombia, *V.* aff. *ferruginea* H. B. K. The woods are very much like that of *Calophyllum Calaba* Jacq. in structure and properties. There are various species in French Guiana, where they are known as: Bois d'artre, b. d'accossais, b. de sang, b. babtiste, b. cossais, b. sanglant, b. de la fièvre, and coaopia. In Trinidad the trees are sometimes called bloodwood, and in Venezuela, "onotello" and "lacre blanco."

There are four known species of *Moronobea* in the Guianas and Brazil. The bark is rich in gum and the wood is hard, strong, and not very durable. The common names are: Manni, manie, manne (B. G.); mangue blanc, aigle montagne, paletuvier jaune, and p. blanc (Fr. G.).

53. BIXACEAE

This family consists of four tropical genera of shrubs or small trees with soft woods without value. *Cochlospermum Gossypium* DC. of India produces a fiber like the kapok of the *Bombacaceae*, which is useful in stuffing mattresses and pillows. The tree also yields a gum of some local value and the bark supplies a fiber for cordage. The wood when green is a soft spongy mass, drying to a loose bundle of fibers. There are species of this genus in various parts of tropical America, those in the Amazon region being known as "periquiteiras," but no information is available concerning them other than that they are minor trees having light wood of no value.

188 Some botanists divide the Guttiferae into distinct families and include *Vismia* in the Hypericineae.

Best known of the family is the anatto, *Bixa Orellana* L., a small tree or shrub native to tropical America and widely planted throughout the tropics for the coloring matter of the seeds. It is usually only 12 to 15 feet high, but occasionally reaches a height of 30 feet and a diameter of a foot. The seeds, which constitute the commercial product of the tree, are borne in a two-valved pod about an inch long and are about the size and shape of grape seeds. They are covered with a thin, soft, slightly sticky, vermilion-colored pulp, which, after removal by maceration and washing, is dried and pressed into cakes or rolls for the market.

Anatto dye was formerly used by the Carribean Indians for painting their bodies and in this way was brought to the attention of the early explorers. It soon became an article of trade and for a time was employed as a dye for cotton and silk, but later came into general use for coloring cheese, butter, candy, soap, and varnishes. Although analin dyes have reduced its importance, it still is in considerable demand in the dairy business both in the United States and in Europe. The principal sources of production are Brazil and French Guiana.

The wood is of a pinkish-yellow color, and of about the consistency of basswood (*Tilia*). The growth rings are distinct, the pores are small, scattered, and arranged in radial groups of two to four. The parenchyma is in very numerous, very fine, short and wavy lines barely visible with lens. The rays are not distinct without lens except on radial surface. Ripple marks are present, fairly regular and distinct, about 75 per inch, with all elements storied, although some of the rays occupy two stories. The wood fibers have bordered pits. The bark is fibrous and suggests *Tilia* in structure. *Material:* Yale No. 4362, collected by Prof. Rowlee in Costa Rica.

Common names: Anatto, arnatto (Eng.); achiote (Sp. Am., gen.); roucou (Fr.); bija, bixa, cacicuto (Cuba); bichet (Carib, women); emátabi (Carib, men); onoto (Venez.); achote, bija, bixa, onoto (Col.); bija, bixa (Pan.); achote (Guat.); achiotillo, arnato, chancanguarica, pumacua, urucu (Mex.); achuete (P. I.).

54. CANELLACEAE (WINTERANACEAE)

The Wild Cinnamon Family consists of five genera[189] and seven or eight species of small evergreen trees with pungent, aromatic bark and very dense wood. The woods are not of commercial importance, with the

[189] *Canella* (West Indies, southern Florida, Colombia, Venezuela), *Cinnamodendron* (three species in West Indies and Brazil), *Warburgia* (East Africa), *Cinnamosma* (Madagascar), and *Pleodendron* (Porto Rico).

possible exception of *Cinnamosma fragrans* Baill. of northern Madagascar, which may be the source of the so-called "taggar" wood exported by way of Zanzibar to Bombay and said to be largely used there as a substitute for sandalwood for funeral pyres.

CANELLA

The wild cinnamon, *Canella Winterana* Gaertn. (= *C. alba* Murr.), the only species of the genus, is a small or medium-sized tree of the West Indies, southern Florida, and parts of Colombia and Venezuela. It is widely distributed on the southern Florida keys and usually grows in the shade of other trees. The bitter acrid inner bark is the wild cinnamon bark of commerce; it has a cinnamon-like scent and is employed as an aromatic stimulant and tonic. In Cuba the wood is sometimes employed in the manufacture of agricultural implements.

THE WOOD

Canella Winterana Gaertn. *Wild Cinnamon.*

Common names: Wild cinnamon, cinnamon bark, whitewood, canella (Fla., Bah.); curbana, canela blanca (Cuba); weisse zimmt (Germ.).

General properties: Color olive-brown; somewhat oily. Sapwood white, thick, sharply defined.

Without characteristic odor and taste in small dry specimens available for study.

Very hard and heavy; air-dry wood sinks readily in water; sp. gr. (oven-dry) 0.99 (Tenth Census). Weight about 62 lbs. per cu. ft. Grain fine. Texture medium. Very strong under compression and indentation, but brittle; highly durable.

Growth rings: Poorly defined or absent.

Parenchyma: Sparingly developed about pores and diffuse; sometimes with tendency to short tangential lines; inconspicuous.

Pores: Small; faintly visible; rather widely and irregularly scattered.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Very numerous; minute; faintly visible on cross section, invisible on tangential, visible, but low and inconspicuous, on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels are thick-walled and have scalariform perforations with many bars. Rays uniseriate or biseriate, the cells variable in size; crystals abundant. Ground mass of wood composed of very thick-walled fiber tracheids with prominently bordered pits.

Remarks: In a specimen of "taggar" wood supplied by Mr. Wilfred H. Schoff, of the Philadelphia Commercial Museum, which corresponds to that

described by Holmes,[190] the structure is very similar, except that the parenchyma is more distinctly in tangential lines and there are large oil cells present as in certain of the Lauraceae. The fact that the ground mass is composed of fiber-tracheids seems, however, to preclude the latter family.

Material: Yale No. 6351 from Elliott's Key, Florida. (Supplied by Prof. I. W. Bailey of Harvard Univer.)

55. FLACOURTIACEAE

This tropical family, extended to include the Samydaceae, consists of about 70 genera with several hundred species, mostly shrubs and small trees of little economic importance. Some of the genera have edible fruits, others yield tanning materials as well as drugs, oils, and resins of more or less medicinal value. The seeds of *Taraktogenos Kurzii* King of the Far East furnish the "chaulmoogra" oil famed for its efficacy in the treatment of leprosy.[191] Only one wood, the "zapatero" or Venezuelan boxwood, *Casearia praecox* Gris., enters the world's markets, though a few others supply good material for local use.

The tropical American genera, with representatives sometimes reaching tree size, include *Oncoba**, *Mayna*, *Carpotroche*, *Prockia*, *Hasseltia**, *Banara**, *Homalium**, *Xylosma**, *Azara**, *Lunania*, *Lactia*, *Patrisia*, *Zuelania**, and *Casearia**. Only *Casearia* and *Homalium* are the source of merchantable timber. The woods exhibit considerable range in density and in color, but to judge from available material of the eight genera marked with an asterisk, they are mostly fine-textured or fairly so, with narrow and inconspicuous rays, very little wood parenchyma, and with medium-sized to minute pores often in short radial groups. They are without figure and the color is not striking. The vessels have simple perforations, though with some tendency to scalariform, particularly in the region of the primary wood. The wood fibers have simple pits.

CASEARIA

This genus contains approximately 200 known species, mostly shrubs and small trees, occurring in practically every tropical region of the world. With one known exception, which may possibly include some closely related forms, they are of little or no economic importance. The woods are whitish or yellowish, mostly fine-textured, rather hard, heavy,

[190] Holmes, E. M.: Museum report, 1895-1902, *Pharm. Soc. Gt. Brit.*, London, 1903, pp. 42-45.

[191] See Rock, Joseph F.: *The chaulmoogra tree and some related species*, Bul. No. 1057, U. S. Dept. Agr., Washington, D. C., 1922.

and compact, and well suited for turnery. The bark is mostly gray and smoothish and contains secretory canals with an oily-resinous content which exudes upon being cut and is sometimes used medicinally. The fruits of some species are used by natives to stupefy fish.

Of the many species in all parts of tropical America only one, so far as known, supplies timber of more than local value. This is the "zapatero," *Casearia praecox* Gris., which is the source of one of the important boxwoods of commerce, variously known as West Indian, Venezuelan, or Maracaibo boxwood. The exact range of this species has not been determined, but it has been collected in Cuba, Venezuela, and Colombia. The timber of the trade comes from the Maracaibo region of Venezuela. The date of the first shipments has not been ascertained, but it is known that some kind of boxwood was being exported from that locality before 1878, though there is some doubt as to whether these early consignments were the "zapatero" or the "amarillo" (*Aspidosperma*), or both together.

"Zapatero" is exported in the form of smooth, straight, round logs, 10 or 12 feet long and from two to 20, mostly six to 10, inches in diameter. The bark is from one-eighth to three-sixteenths of an inch thick, indistinctly two-layered, the outer layer being thin, smoothish, brown or mottled, and with fine vertical wrinkles in the smaller sizes and flaking off irregularly in the larger to a light gray without furrows, suggesting sycamore (*Platanus*). The inner layer has distinct wedge-shaped rays and shows fine laminations and, when fresh, exudes an oily resin which shows as a dark ring around the ends of the logs.

This wood is used as an acceptable substitute for true boxwood (*Buxus*) for mathematical instruments, particularly rulers, and for shuttles, turnery, musical instruments, burnishing wheels, and all other boxwood purposes except for the highest grade of wood engravings. In common with the other boxwoods of commerce, "zapatero" logs must be seasoned with care to prevent splitting and staining. This is readily accomplished by storage under cover with proper attention to the circulation of air. The largest logs, which are in demand for veneers for cabinetwork, are commonly sawed through the middle to avoid checks in seasoning.

THE WOOD

Casearia praecox Gris. *Zapatero.*

Common names: Zapatero, sapatero, naranjillo, lima, limoncillo (Venez.); West Indian, Venezuelan, or Maracaibo boxwood (Trade, gen.); India boxwood (Eu. trade); buis d'Amérique (Fr.). Other species: Jía blanca, jía brava, raspalengua, rompehueso, sarna de perro, sarnillo (Cuba); cafeillo,

cafeillo cimarrón, cafetillo, cotorrerillo verde, caracollillo, cereza, laurel espada, robojunco, robo ratón, palo blanco, sarna de perro, talatron (P. R.); guassatunga, anavinga, pitumba (Braz.); rajador, palo rajador, guazatumba, catiguá blanca, catiguá-obŷ, catiguá verde, mbavŷ, mbabí, baví, avatí tymbati, yerba de lagarto (Arg.); cerillo, raspa lengua (C. R.); guabillo, manocarpa, vara blanca (Guat.); cerillos, comida de culebra (Nic.); cafetillo, capulincillo, chilillo, crementillo, guayabillo, palo de piedra corteño, pochitoquillo (Mex.).

General properties: Color light clear yellow or nearly white; mostly uniform; little or no difference between heart and sapwood. Blue-stain common in improperly seasoned wood.

Odor and taste absent or not distinctive.

Hard, heavy, compact. Sp. gr. (air-dry) 0.80 to 0.90. Weight 50 to 56 lbs. per cu. ft. Texture extremely fine and uniform. Grain mostly straight. Wood easy to carve and turn; takes a high natural polish; not durable in contact with ground.

Growth rings: Fairly distinct, due to fine, concentric, light-colored lines resembling parenchyma. Examination with compound microscope shows that these lines result from a certain alignment of the wood elements at intervals presumably corresponding to seasonal changes.

Parenchyma: Absent. (See above.)

Pores: Very numerous; not distinct without lens; mostly in radial rows of two to four or more.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Very fine, but visible on cross section; invisible on tangential; fairly distinct on the radial surface, where they are of the same color as the background, though reflecting the light differently.

Minute anatomy: Vessel perforations simple; intervascular pits very small, with slit-like apertures which may extend beyond borders and appear to coalesce into spirals. Rays heterogeneous; one to three cells wide and few to 75 cells high; crowded; pits into vessels very small, half-bordered, with lattice-like appearance. Wood parenchyma absent or very rare. Fibers with gelatinous layer in part; often in definite radial rows due to crowding of rays; sometimes falsely septate with resin plates; pits simple, but usually very distinct.

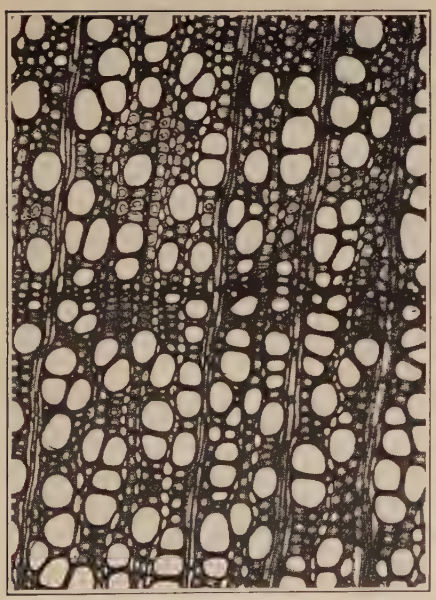
Remarks: There is considerable variation in the texture of the woods of the different species, some being rather open and too porous for use as boxwood.

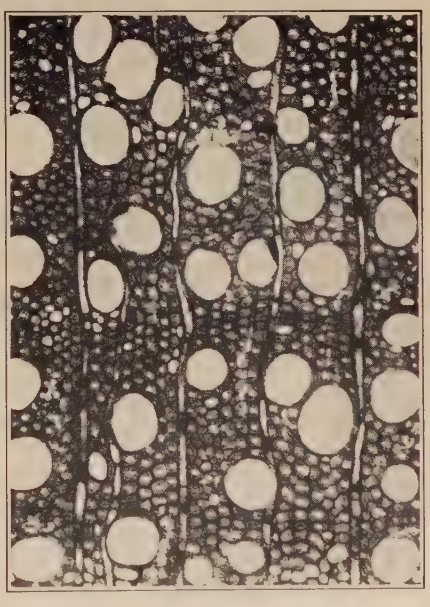
The woods of the true boxwood (*Buxus*) have scalariform perforations between the vessel segments, while all of the substitutes have simple perforations. For further details see Record, S. J.: Boxwoods of Commerce, *Bul. Torrey Bot. Club*, 48: 297-306, Jan. 19, 1922.

Material: Yale Nos. 2663, 2675, 2735, 2759, 4424, 4425, 4426 (Venez.). Other species: Yale No. 3719 (Hond.).

Photo by Miles Haman.

Chairs made of Cactus (Cardón), Venezuela.
(Cereus sp.)





Photos by James Austin.

Cross Sections of Venezuelan Boxwoods: Zapatero and Amarillo (x 50).
(Casearia praecox.) *(Aspidosperma Vargasii.)*

HOMALIUM

This genus, with upward of a hundred species, is widely distributed throughout the tropics. There are numerous species in Africa and the Indo-Malay region, and *Homalium tomentosum* Benth. is considered one of the finest timber trees of Burma; its hard compact wood, variable from white to red in color, is sometimes known as Moulmein lancewood. The woods of the various kinds in the Philippines are much alike in structure and properties, though exhibiting a wide range of color, including yellowish, pinkish, pale red, reddish to chocolate-brown, and sometimes variegated. They are very durable in contact with the ground, rarely attacked by termites and but slowly by teredo, and are used for piling, posts, cross-ties, and exposed work in general, and also for floors, interior finish, and furniture.

The 20 tropical American species are very closely related and belong to the section *Racoubea* of the subgenus *Myriantheia* (Warburg). The area of distribution includes southern Mexico, Central America, Colombia, Venezuela, the Guianas, Brazil, and most of the West Indies. The trees are mostly small, though occasionally reaching a height of 60 to 75 feet, and rarely upward of 100 feet (Panama), with a diameter of 12 to 20 inches. Although the wood is not exported, it is highly esteemed locally for general construction, carpentry, and furniture. In Venezuela it is considered one of the best native cabinet woods. On account of its moderate hardness and high durability it is well suited for railway ties.

THE WOOD

Homalium sp. *Angelino.*

Common names: Angelino, angelino laurel (Venez.). Other species: Tostado, carocolillo, cerezo (P. R.); acouma (Mart.); acomat, acoma blanc, acoma sauvage (Guad.); bita hoedoe (Sur.); acomas à épis, acomas en épis, acomas à grappes, bois d'acouma, bois incorruptible, mavavé, mavévé, racoube de la Guyane (Fr. G.); white cogwood (Jam.); palo de piedra (Mex.).

General properties: Color fairly uniform yellow, brownish-yellow, or dark olive; lustrous. Sapwood light yellow; not sharply defined.

Odor and taste absent or not distinctive.

Moderately heavy and hard. Sp. gr. (air-dry) 0.75. Weight about 47 lbs. per cu. ft. Grain somewhat roey. Texture medium. Wood easy to cut, takes high natural finish, strong, and durable. Resembles some of the woods of the Lauraceae in color, luster, and texture.

Growth rings: Present, but not very clearly defined; due to variation in density and depth of color.

Parenchyma: Associated with pores; indistinct.

Pores: Small; visible; numerous or fairly so; well distributed; occurring singly or more often in radial groups of two or three, occasionally more.

Vessel lines: Fine; often short; distinct, and sometimes rather conspicuous.

Vessel contents: Tyloses present. Some vessels lined with dark-colored gum.

Rays: Numerous; fine; visible on cross section; faintly visible on tangential; low, but distinct, on radial surface; homogeneous.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: One specimen (Yale No. 2677) is considerably denser and has fewer pores than the others.

Material: Yale Nos. 331, 348, 464, 2667, 2677, 6667 (Venez.); also 1677, and 2297 from Philippines for comparative study.

56. CACTACEAE

The Cactus Family consists of many genera and a very large number of species which are succulent and spiny trees or shrubs adapted for growth in a desert climate. It is most abundantly represented in the arid region of southwestern United States and northern Mexico, a few species extending as far southward as Chile. Some of the plants, species of *Cereus*, for example, have a columnar form, rarely 60 feet high and two feet in diameter, and within these fleshy stems are skeletons of wood for which there is considerable local use because of the scarcity of other timber.

Haman[192] says: "From La Vala de Coro west to Casigua, Venezuela, a distance of 100 miles, the topography is extremely flat and here the open stands, with a ground cover of *Opuntia* and *Melocactus*, cover practically the whole area. The most characteristic species of this section is the 'cardón,' *Cereus* sp., in places occurring as pure forests. This cactus sometimes attains a height of 40 feet and is of such dimensions that it is used locally for lumber. Logs six feet long that will square eight inches are obtainable, and practically all the chairs and small tables seen in the homes in this section are made of 'cardón.' It is a pretty wood, cream-white to yellow in color, showing ray flecks suggesting sycamore (*Platanus*), and sufficiently strong and durable for the purposes named." (Plate XLIV.)

THE WOOD

Cereus sp. *Cardón.*

Common names (various species): Cardón, c. de brava, c. de dato, c. de guanarije (Venez.); giant cactus (U. S.); cabeza viejo, hombre viejo, pitahaya, p. dulce, saguaro, sahuara, sina, sinita, suwarro, zina (Mex.); cardón, c. del Paraná, dayamí, tuna, ucle (Arg.); jumbeba, mandaracu (Braz.).

[192] Haman, Miles: *Forests of Venezuela,* MS. in library of Yale School of Forestry.

General properties: Color pale yellow; uniform. No differentiation into heartwood and sapwood.

Odor and taste not distinctive.

Moderately hard and heavy, fairly tough and strong. Grain straight to somewhat irregular and wavy. Texture rather coarse. Wood easy to work, finishes smoothly, takes a fair polish, is said to be durable.

Growth rings: Absent; sometimes indicated by tangential arrangement of pores.

Parenchyma: Scantily developed about vessels; indistinct.

Pores: Very small; not distinct without lens; numerous, well distributed; tendency to tangential arrangement.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Coarse; prominent on cross, inconspicuous on tangential, conspicuous on radial surface in proper light, but without contrast in color from background. Component cells readily visible under lens.

Ripple marks: Absent.

Gum ducts: No true gum ducts present, but there are numerous small to very large intercellular channels running through some of the rays and giving a pitted appearance to the tangential surface of the wood ribs.

Minute anatomy: Vessels with simple perforations; pits variable in size and shape, often large and irregular. Rays four to seven cells wide and 100 or more high; heterogeneous; cells coarse and mostly upright; pits into vessels large, gash-like, with narrow, irregular borders, and sometimes scalariform. Parenchyma about vessels; cells coarse; pitting conspicuous. Wood fibers with numerous simple pits, though in surface view some of the pits are apparently bordered.

Remarks: The wood of the giant cactus of Arizona, *Cereus giganteus* Engl., is soft and light, its sp. gr. (oven-dry) being 0.32 (Tenth Census). The wood is used in the region almost exclusively for the rafters of adobe houses and for fencing. The wood of *C. cochal* Orc. of Lower California is as hard and strong as oak and has very few pores.

In *Pereskia portulacifolia* (L.) How. (Yale No. 4817, from Haiti), the structure is somewhat similar to that of *Cereus*, but the rays are lower and the canals are wanting.

Material: Yale Nos. 2873, collected by Messrs. Curran and Haman on Venezuelan coast; 5213 (Ariz.); 6686, 6687 (Lower Calif.); 3421 (Braz.).

57. THYMELAEACEAE

The Leatherwood Family, consisting of about 40 genera, is represented in nearly every part of the world. Most of the plants are shrubby, some are small trees, and a few develop into large trees. The most famous representative is *Aquilaria* of the Indo-Malay region. This yields the eaglewood of commerce, the lign aloes of the ancients, which is procured in the form of irregular masses of heartwood saturated with a

resin and essential oil with a fragrance of honey, and prized for incense and perfume. The structure of this wood is anomalous, bast occurring as internal strands, which explains why the tree is not killed when the bark is removed by the natives for writing material and other purposes.

The plants are characterized by having soft, white, brittle wood, and very tough fibrous bark. A typical example is our leatherwood, *Dirca palustris* L., a shrub noted for the extreme toughness and pliability of its fresh bark. There are several genera of shrubs and small trees in tropical America, and one, the "pillo-pillo," *Ovidia Pillopillo* Meissn., occurs in Patagonia and Chile. The "embira branca" of Brazil, *Daphnopsis brasiliensis* Mart. and *Funifera utilis* Leandr., supply a limited amount of wood for interior work, boxes, and paper pulp; their bark is a source of fiber for cordage; the leaves contain an alkaloid, "daphnina," that is poisonous to cattle.

The lace-bark tree, *Lagetta lintearia* Lam., is a small tree or shrub growing chiefly on limestone rocks throughout the West Indies, where it is variously known as "lagetto" and "daguilla" (Spanish), gauze, Indian lace, and linen lace-bark (English), and "spitzenbaum" (German). It is remarkable for its bark, the inner portion of which consists of many thin laminations which readily separate and present a striking similarity to fine lace. It has long been used, not only for cordage, but also for articles of wearing apparel and adornment. It is said that Charles II received from the governor of Jamaica a cravat, frill, and pair of ruffles made of this bark. The macerated fibers serve as an excellent pulp for making paper, but the difficulty of securing it in sufficient quantity prevents its extensive use. The wood of the American genera is, so far as examined, of normal structure, of which *Dirca* may be taken as the type. *Material:* Yale Nos. 1755 (Arg.); 5268 (W. I.).

58. LYTHRACEAE

The Loosestrife Family consists of over 20 genera and about 300 widely distributed species of trees, shrubs, and herbaceous plants. Some of the members are important sources of dyestuffs. The Egyptian henna, *Lawsonia inermis* L., is a small shrub cultivated as a hedge plant and for its leaves, which yield the henna dye used for imparting an orange-yellow or brownish-yellow color to the nails, skin, and hair, and also to leather; its use is known to date back to the time of the early Egyptians.

From the standpoint of the timber, interest is centered in the Indo-Malayan region, where at least three genera contain species of importance. The wood of the "jarúl" or "pyinma," *Lagerstroemia Flos-*

Reginae Retz, is said to be one of the finest of Indian timbers, while those of several other species are nearly as good. There are two or three arborescent genera in tropical America, but they do not yield timber of importance.

PHYSOCALYMMA

The single species, *Physocalymma scaberrimum* Pohl (= *P. floridum* Pohl = *Diplodon arboreus* P. & E.), has long been supposed to be the source of the Brazilian tulip wood, known locally as "sebastião de arruda." Through the courtesy of the New York Botanical Garden, opportunity was afforded for a study of the wood of *Physocalymma* collected with botanical material in Bolivia by Mr. R. S. Williams. The structure of this wood corresponds with other known material of the Lythraceae and is fundamentally different from that of the tulip wood, which is undoubtedly one of the Leguminosae. Owing to this confusion of names some of the published statements regarding this species must be accepted with reservations.

According to Koehne[193] the known distribution of *Physocalymma* is along the rivers Beni and Madre de Dios in Bolivia, Yurimaguas in Peru, the Rio Negro and near Manaos on the Amazon in Brazil, and also in the States of Goyaz and Matto Grosso. It is said to be a tree from 20 to 75 feet high and 12 to 18 inches in diameter. Williams' specimen (previously referred to) was from a tree 10 inches in diameter and 35 feet high, growing at an altitude of 4000 feet along the Chiarra Rio.

THE WOOD

Physocalymma scaberimmum Pohl

Common names: Unknown. (The names tulip wood, rosewood, páo rosa, sebastião de arruda, etc., are incorrectly applied to this wood. (See p. 288.)

General characters: Color somewhat pinkish; not distinctive; suggests that of maple or birch. Sapwood not sharply defined.

Odor and taste absent or not distinctive.

Moderately hard, comparing with red maple (*Acer rubrum*). Grain straight or fairly so. Texture uniform; medium. Wood easy to cut, finishes smoothly, does not appear durable; is not a cabinet wood.

Growth rings: Present, but not very distinct; due to slight increase in density of wood.

Parenchyma: In narrow circles about the pores; visible with lens, but not very distinct.

Pores: Rather small, but visible; fairly numerous, but not crowded; well distributed; occurring singly or in short radial groups as though subdivided two to five times.

193 Engler's *Pflanzenreich*, IV, 216, Lythraceae, Leipzig, 1903, pp. 210-211.

Vessel lines: Visible as long inconspicuous scratches.

Vessel contents: Some tyloses present.

Rays: Very fine, but visible, on cross and tangential sections; distinct, but not conspicuous, on radial surface, appearing considerably darker than background; of fairly uniform height, but not storied.

Ripple marks: Absent.

Minute anatomy: Vessels with simple perforations; intervascular pits rather large, with slit-like apertures; tyloses thin-walled. Rays heterogeneous; one to three cells wide and few to 25 cells high; pits into vessels large and elongated, often in scalariform arrangement, simple, with a tendency to bordered at times. Parenchyma sparingly developed. Fibers with minute simple pits; often septate. A highly characteristic feature is the presence of large oil or resin cells located at intervals along the margins of the rays and also in the wood parenchyma strands; they are very thin-walled, have yellowish contents, and are distinct on all three sections.

Remarks: The specimen described is from No. 1474 in herbarium of the New York Botanical Garden.

59. LECYTHIDACEAE

The Monkey-pot Family, sometimes included in the Myrtaceae, is confined to tropical America and consists of 12 genera, according to the classification of Miers,[194] though another genus, *Goeldinia*,[195] was subsequently established by Huber. There are over 200 species, all trees, many of them of gigantic stature. The leaves, which vary in size from a few inches to nearly three feet in length, are simple, alternate, and without pellucid dots. The flowers are in terminal racemes or panicles and are often large and showy. The fruits are very characteristic and have frequently been made the basis for specific distinctions. They are hard and woody, variable in size, but often very large, and nearly always with an opening which, until maturity, is closed by a lid-like structure. They contain several winged seeds or more often few to many nut-like seeds, some of which, particularly the Brazil nuts and the paradise or cream nuts, are important articles of commerce. The inner bark is composed of numerous thin layers of bast for which various important uses are found.

The woods have considerable local utility at present and give promise of becoming of very much greater importance in the future. Some are comparatively light, soft, and easily worked, while others are extremely hard and heavy. There is a like range of variation in the color—yellow-

[194] Miers, J.: On the Lecythidaceae, *Trans. Linnean Society of London*, 30: 157-318 (1874).

[195] *Bol. Mus. Goeldi*, 3: 438. This genus is very closely related to *Allantoma*, and contains a few Brazilian trees known as "churú" in Pará.

ish, olive, brown, or dark red—with red and brown predominating. They are mostly without distinct scent, but in a few instances are said to have a very fetid and nauseous odor when fresh. The most distinctive structural feature is the presence of numerous concentric layers of wood parenchyma, which vary from fine and indistinct to as wide as the fiber layers between them. The pores are of various sizes, are not very numerous, and usually exhibit some tendency to radial arrangement. The rays are usually narrow, but rather high, showing distinctly only on radial surface, in some cases producing a rather conspicuous silver grain. Large vertical gum ducts, similar to the "gum veins" in *Eucalyptus*, sometimes occur as the result of injury. (Plate XLVII.)

The vessels have simple perforations, numerous small bordered pits, and are usually filled with thin-walled tyloses. The rays are homogeneous or nearly so; are one to eight, mostly two or three, cells wide, and few to many cells high; and the pits into vessels are small and half-bordered. Crystals of calcium oxalate are common and are sometimes very abundant; they are mostly very small and usually found in chambered strands of the size and shape of wood fibers, commonly located at the margins of the parenchyma laminae, but occasionally diffused. The wood fibers are generally thick-walled with narrow cavities and small, simple or indistinctly bordered pits. The pitting of the fibers serves to distinguish these woods from certain of the Rosaceae with which they are sometimes confused.

GUSTAVIA

This genus consists of over 25 species of small or occasionally medium-sized trees widely distributed in northern South America. Their leaves are usually crowded at the ends of the branches and vary in length in different species from four inches to nearly three feet. The flowers are yellow and showy. The fruits are globular pyxidiums about the size of an apple, with a leathery pericarp and, when ripe, with a pulpy interior which escapes through the opercular opening and carries with it the numerous bean-like seeds. The "membrillo" (quince) of Colombia and Panama, *Gustavia superba* Berg., has edible fruit.

The woods vary in color from yellowish to reddish-brown with black streaks, and are generally characterized by a fetid odor that is very pronounced in the fresh material. They are hard and heavy to moderately so, tough and strong, fine-textured, and take a good polish. The pores are small and numerous, mostly in radial groups of two or three. The parenchyma is in very closely spaced wavy lines a single cell in width. The rays are one to five cells wide and up to 50 or more cells high.

Common names: Bejuco de lucá, membrillo (Pan.); baco, chupa, membrillo (Col.); chope, sachavaya (Peru); chope, sacha-chope, sachavaya, geniparana, geniparana da matta (Braz.); pirigaramepé (Galibis); bois puant, bois piant (Fr. G.); stinkhout, watra mama bobbie, aripawana (Sur.).

COUROUPITA

There are about a dozen known species of this genus in northern South America and in Central America, mostly large trees. The flowers are large and showy and occur generally on vine-like peduncles issuing from the trunk or old bare branches. The fruits, which resemble cannon balls, have a cap (operculum) which, instead of falling off, is drawn inward by the contraction of the central column attached to it.

The following notes are from Miers (*loc. cit.*, pp. 189-194): *Couroupita surinamensis* Mart. is "a very large tree" of Surinam. *C. antillana* Miers of the West Indies is "a tree 50 to 60 feet high, with a trunk more than two feet thick, and a soft wood." *C. peruviana* Miers of Peru is "a very large tree about 100 feet high, with a softish wood, known by the name of 'aiaúma' (*caput mortui*), probably from its large round fetid fruit. . . . The pulp on exposure to the air becomes black and fetid. It is used by the natives to cure skin diseases in animals." *C. odoratissima* Seem. of Panama is "a lofty tree, 60 to 80 feet high, growing in the forest, the trunk bare to the height of 20 feet, and bearing many racemes, with handsome flowers as large as those of a passion-flower, from a resemblance to which it bears the vernacular name of 'granadillo'; it is also called 'palo de paraiso' . . . The fragrance of the flowers can be perceived at a distance of half a mile." *C. membranacea* Miers of Colombia is "a tall tree, occurring in plains (not in the forests), and, as in some other species of the genus, with the inflorescence issuing from the main trunk or its bare branches. . . . The petals . . . when fresh are succulent, and yield a blue juice when squeezed."

C. guianensis Aubl. is known as cannon-ball tree in British Guiana, and as "castanha," "cuia do macaco," and "aiauman" in the Amazon region of Brazil, where it is a tall tree of the flood plains. In French Guiana it is called "couroupitoumou," "boulet de canon," "abricot de singe," and "calebasse colin." In Trinidad the French name is "arbre à bombes," the Spanish, "múco." The tree is cultivated in Cuba and bears the name "bala de cañón."

C. darienensis Pittier of Panama is said to be a very large deciduous tree with a straight trunk reaching up to 100 feet in height and four feet in diameter, from the apex of which the main limbs radiate horizontally, forming a flat, sparsely branched crown. It grows singly and widely scattered in the virgin forests and is remarkable for its gigantic

Cannon-ball Tree in Trinidad.
(*Couroupita guianensis.*)

Group of Brazil-nut Trees in Brazil.
(*Bertholletia excelsa.*)

PLATE XLV

stature. The wood is of a grayish-brown color, the thick sapwood nearly white; the odor of the fresh material is fetid and very repulsive. It is hard and heavy, strong, tough, usually cross-grained, rather coarse-textured, works fairly well, and finishes smoothly. The pores are large, rather few, occurring singly or more often subdivided radially two to several times. The wood parenchyma is in very numerous, minute, irregular, tangential lines, one cell wide. The rays are two to five cells in width and up to 40 cells high; they are visible on cross section and conspicuous on radial surface. There are no known uses of the wood. The common names are "coco de mono" and "coco zapote."

BERTHOLLETIA

There are two known species of this genus, namely, *Bertholletia excelsa* Bondpl. and *B. nobilis* Miers, lofty trees abundant in the forests of northern Brazil and the Guianas and the best known of the family because they produce the Brazil nuts of commerce. The first species attains a height of over 100 feet, with a long clear trunk from two to four feet through, and with undivided leaves sometimes six inches wide and twenty-four inches long. The other species, according to Miers (*loc. cit.*, p. 198), "forms a tree above 120 feet high, with a trunk 14 feet in diameter up to a height of 50 feet, and quite bare to a height of 100 feet; its leaves are 10 to 15 inches long, 3¾ to 4½ inches broad."

The fruit is a thick-walled, woody capsule, four to six inches in diameter, tightly packed with 20 or more large angular seeds with a hard, black shell filled with a rich, creamy, white kernel. The capsule does not open and liberate the seeds as in other genera of this family, but falls to the ground with the seeds inside. Miers says (*loc. cit.*): "The question here naturally arises, how do the seeds germinate and strike root, confined as they are in an inextricable prison? For it is manifest they cannot find an exit through the opercular opening, and they cannot escape by any other means than by the rotting of the thick pericarp on moist ground; and it would probably require three years' exposure to the sun and moisture before so thick a shell could decay sufficiently to allow of the liberation of the seeds, and then perhaps another year's exposure before the thick testa of the seeds could rot sufficiently to allow the embryo to germinate. This shows an extraordinary power of vitality in the embryo, which would seem to remain four or five years in a dormant state. Oily seeds generally are supposed to ferment and decay soon; but that perhaps is where the oil cells are contained in the albumen; here, however, we find a reverse condition. I have been told that when the embryo of *Bertholletia* has been extricated, and planted

under the most favorable circumstances, it takes a whole year before it begins to germinate. Is this inertness due to the large amount of stearine in the oil-cells which preserves it from decay?"

The kernels contain between 60 and 70 per cent of oil, composed of elaeine (74 per cent) and stearine (26 per cent), which is generally esteemed for domestic purposes, as a substitute for olive oil, and also for industrial uses. Most of the seeds or so-called nuts, however, are used as confections and form a staple article of trade, being known as Brazil, Pará, or cream nuts.

The empty woody capsules are used locally for fuel and also for making cups and other utensils and ornamental articles. Another interesting product of the Brazil-nut tree is the bark, the fibrous inner portion of which is highly valued for making oakum used so extensively in Brazil for calking vessels.

The wood is not extensively used, probably because the easily accessible timber is protected on account of its fruit. It is of good quality, hard, heavy, strong, tough, and durable, well suited for all kinds of construction and for use in exposed places.

Common names: Castanheira, castanheiro, castanheiro do Pará, castanha, nhâ, niâ, tuca (Braz.); almendro (Col.); yuvia (B. G.); juvia (Span.); Brazil-nut tree (Eng.); Brasilnussbaum, Paránussbaum (Germ.).

LECYTHIS

This important genus includes many species of rather small to very large trees which are commonly called monkey-pot trees on account of their peculiar fruits.

Miers says (*loc. cit.*, p. 162): "These species form some of the most ornamental trees of the forest, being generally from 20 to 60 feet high, with a copious foliage, a solid timber of considerable use, with a soft inner bark of some thickness, easily detached, and which, beaten while fresh, resolves itself into numerous distinct membraneous sheets. Poiteau relates that he counted as many as 110 of these laminae in a single flake of the bark; it is called 'estopa' (oakum) in commerce, and is applied to many useful purposes. The leaves of the true *Lecythis*, compared with those of the excluded species, are generally smaller, of much thinner texture, of a brighter color, and finely serrated on the margin; but in a few species they are entire, with small specks on the margin, indicating the abortive teeth. . . . The fruit is a pyxidium, usually of great size, very thick, densely ligneous, extremely variable in form, and always marked by two concentric lines. . . . The fruit, from its weight, naturally hangs in an inverted position; and when ripe a swelling is at first

noted around the opacular zone; and afterwards, by the rupture of the central column, the operculum falls off with a portion of the column attached to it. The numerous seeds, sustained by their funicles, now hang down in a bunch and soon fall to the ground, the main body of the shell remaining long suspended from the lofty tree; at this period the fleshy mass of the funicles ferments, and exhales a very nauseous odor. . . . The seeds of the species abundant in the Province of Pará are exported to Europe in considerable quantities, and sold here in the shops as 'sapacaia-nuts.' "

The woods of *Lecythis* are usually of a brown or reddish color; they are mostly hard, heavy, tough, and strong; some of them are durable, others not. The pores, which are often in radial groups, are in some instances too small to be distinct without a lens, while in others they are rather large and readily visible. The concentric lines or bands of parenchyma are fairly regular and uniformly spaced, but vary greatly in width. For example, in the wood of *L. ampla* Miers (Yale No. 2985*, Panama) the lines are mostly only two or three cells wide, about one-fourth the width of the fiber layers, and too narrow to be distinct without a lens; while in the "olla de mona" or "olleto" of Panama, *Lecythis Melliana* Pittier, the parenchyma is in very distinct layers fully as wide as the fiber layers. This laminated structure produces a more or less conspicuous pattern on the tangential surface, and when a stick is broken the resulting fracture is splintery. Wood with wide parenchyma bands tends to go to pieces when subjected to impact across the grain.

Many of the Brazilian species are known as "sapucaia," the Tupa Indian word for hen. Mr. Curran says: "The 'sapucaias' belong to the group of monkey-pot trees common over a large part of tropical South America and constitute one of the most common features of the Brazilian forests, both in the Amazon lowlands and in the coastal mountain forests. It is common to find trees with somewhat buttressed boles, five or six feet in diameter, and free of limbs for 50 to 60 feet. The crowns are composed of stout wide-spreading branches and shed most of their leaves during the dry season, becoming almost bare. The light-colored flowers are borne in profusion, and though scarcely noticeable while on the tree, they carpet the ground for a week or two during their fall. The fruits are great balls, dark brown when ripe, with a circular opening closed by a lid which eventually falls away and lets the seeds escape. The seeds are of about the size of the Brazil-nuts of commerce, but differ from them in having a smooth and somewhat wrinkled brown shell that is not sharply angled. They have a sweet and creamy kernel and are known in the trade as paradise or cream nuts, but are not extensively exported, partly because of the local demand for them and also on account of the

difficulty in collecting, the bulk being eaten by monkeys and other animals of the forest."

Mr. Curran collected wood specimens (Yale No. 4693*) and herbarium material of the common "sapucaia" of the Bahia region, which has been identified as *Lecythis ollaria* L. The trees are found along all of the waterways and, while not very numerous, are a very conspicuous feature of the forest because of their large size. The laminated inner bark supplies material for oakum, cigarette papers, and tinder, and is also used in tanning. A reddish sap is obtained by tapping the trees and is said to make a refreshing drink. The large woody fruit shells are used for ornamental and various domestic purposes. The seeds are a valuable article of food and yield about 40 per cent of oil suitable for cooking and for industrial purposes. The timber is employed in heavy construction, bridges, railway ties, posts, carpentry, and cabinetwork.

THE WOOD

Lecythis ollaria L. *Sapucaia.*

Common names: Sapucaia, sapacaia, sapucaya, sapucaia grande (Braz.); monkey-pot, cream-nut tree, sapucaia-nut tree (Eng.). MISCELLANEOUS SPECIES: Sapucaia, sapucaia branca, sapucaia mirim, sapucaiu, páo macaco, cuyas de macaco, jacapucaya, inhahyba (Braz.); monkey-pot, kakaralli ?, wadaduri (B. G.); canari-macaque, marmite de singe, quatélé, mahot, maho jaune (Fr. G.); coco de mono, cauchillo (Col.); coco, olla de mona, olleto, rule wood (Pan.); cocobola (C. R.).

General properties: Color red or reddish-brown; fairly uniform. Sapwood yellowish; sharply defined.

Odor and taste absent or not distinctive in dry specimens.

Very dense, hard and heavy. Sp. gr. (oven-dry) 0.95. Weight about 60 lbs. per cu. ft. Grain straight. Texture medium. Wood hard to cut, harsh and splintery, strong and tough, splits readily, finishes smoothly, looks highly durable.

Growth rings: Distinct or fairly so; due to more distinct and even line of parenchyma.

Parenchyma: In very numerous fine concentric lines of about the width and spacing of the rays, with which they produce a network resembling a spider web; visible on cross and longitudinal sections, but not conspicuous; mostly one or two cells wide.

Pores: Rather large and distinct; elliptical; not very numerous; well distributed; occurring singly or in small groups; closed with tyloses.

Vessel lines: As long, rather coarse scratches; not conspicuous.

Vessel contents: Tyloses abundant; lustrous.

Rays: Fine, but distinct on cross section, being widest about pores; invisible or nearly so on tangential; distinct, but not conspicuous, on radial surface, where they are of the same color or lighter than background; two to

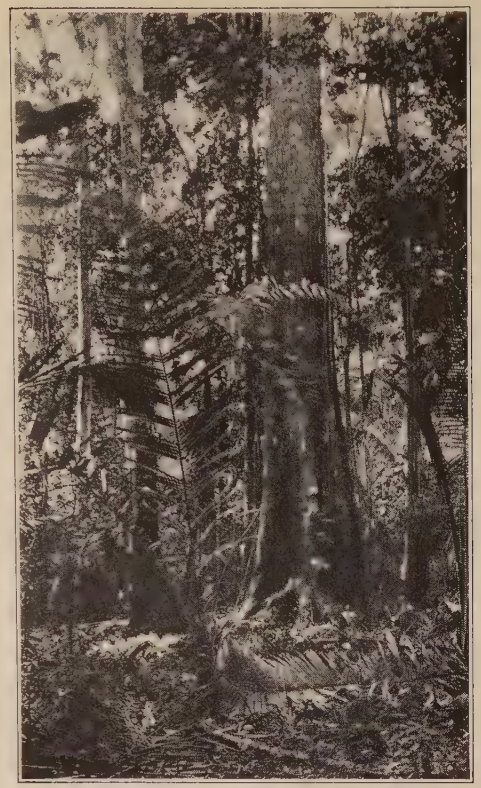


Photo by H. M. Curran.

Sapucaia in Coastal Forest of Bahia, Brazil.
(*Lecythis ollaria.*)

Photo by H. M. Curran.

Peroba Rosa in Misiones, Argentina.
(*Aspidosperma polyneuron.*)

five, mostly two or three cells wide and greatly variable in height, with tendency to be heterogeneous.

Ripple marks: Absent.

Gum ducts: Coarse vertical ducts sometimes present as result of injury, resembling the so-called "gum veins" in *Eucalyptus*.

Remarks: The wood suggests "massaranduba." In a specimen (Yale No. 3197) of "sapucaia mirim," the parenchyma are crowded more closely together near the periphery of the growth rings and produce a lighter-colored zone distinct on all sections.

Material: Yale Nos. 1813*, 3285*, 3914, 4382, 4693*, 4041 (Braz.). Other species: Yale Nos. 597, 602, 613, 4008 (Braz.); 408*, 423*, 2593 (Col.); 2975*, 4338* (Pan.); 4778 (C. R.). Asterisk indicates botanical material.

CHYTROMA

This genus consists of about 25 species of small to large trees occurring mostly in the Amazon region and in the Guianas. *Chytroma* is very closely related to *Lecythis*, but the fruits are smaller and the few seeds contain a tough, dark green, exceedingly bitter kernel quite different from the white, sweet, almond-like kernels of the "sapucaia" nuts. The seeds of the "sapucaia amargosa" of Brazil, *Chytroma amara* Miers (= *Lecythis amara* Aubl.), are the source of a bitter oil used for industrial purposes.

C. turbinata Miers (= *L. turbinata* Berg.) is one of the trees which the natives of Brazil call "macacarecuya" (monkey-cups). It is a low, much-branched tree growing in the inundated lands along the rivers in the Amazon region. *C. Idatimon* Miers (= *L. Idatimon* Aubl.) is a tree 60 to 80 feet high and two or three feet in diameter, known as "idatimon" in French Guiana, "mutunata" in Brazil, and as "watercare," "guatecare," "guatecaro," and "aquatapana" in Trinidad. The wood is said to be hard and heavy, with a specific gravity of 0.90; it is very durable and is used for posts and outdoor work.

The "jaraná" of the Amazon region, *C. Jarana* Huber, is a large tree of the forests of the Bragança railroad. The wood is considered of first quality for railway cross-ties and for the framework of houses.

THE WOOD

Chytroma Jarana Huber — *Jaraná.*

Common name: Jaraná (Braz.).

General properties: Color light reddish-brown, deepening upon exposure; uniform. Sapwood yellowish; sharply defined.

Odor and taste absent or not distinctive.

Dense, hard, heavy. Sp. gr. (air-dry) 0.98. Weight about 61 lbs. per cu. ft.

Grain straight. Texture medium. Wood not easy to cut; rather harsh, splits readily, finishes smoothly, appears durable.

Growth rings: Fairly distinct, due to zones composed almost wholly of fibers alternating with zones of pores and concentric lines of parenchyma.

Parenchyma: In fine, more or less wavy concentric lines connecting pores in interior of ring and nearly independent of them near periphery; mostly two or three cells wide; rather closely, but unevenly, spaced; distinct on cross section; inconspicuous on longitudinal surfaces, appearing somewhat lighter than background in proper light.

Pores: Rather small, but visible without lens; fairly numerous in outer two-thirds of growth ring; occurring singly or subdivided radially; linked tangentially by fine parenchyma lines.

Vessel lines: Fine, straight, inconspicuous.

Vessel contents: Tyloses present; lustrous.

Rays: Very fine, but visible without lens on cross section; invisible on tangential; very distinct on radial surface, appearing of lighter color than background; many 0.05 inch high; mostly two or three cells wide.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Rather closely resembles a specimen (Yale No. 2591) of "guayacan coco" from Colombia.

Material: Yale No. 3916 (Braz.).

ESCHWEILERA AND JUGASTRUM

Both of these genera are closely related to *Lecythis* and are included in that genus by some botanists. According to Miers (*loc. cit.*, pp. 246-275), *Eschweilera* consists of 46 species of medium-sized to very large trees confined largely to Brazil and the Guianas. The fruits are small with a few wrinkled seeds having tough, green, very bitter kernels, as in *Chytroma*. The few known species of *Jugastrum* occur in the same region and exhibit a similar variation in size, but the seeds are roughly four-angled as though whittled off, and their kernels are of a pale brown color with darker specks.

Huber[196] says that "the 'matamatá' of the Amazon region supplies a timber in demand for hydraulic works, particularly for the supports of bridges and warehouses, because of its great resistance to the attacks of the teredo. There are two species, namely, *Eschweilera coriacea* Mart. (= *Lecythis coriacea* DC. = *Jugastrum coriaceum* Miers), and *Eschweilera Matamata* Huber."

The available specimens of "matamatá" (Yale Nos. 3915, 4044) resemble very closely those of the "manbarklak" of Surinam (Yale Nos. 4164, 4196, 4956), the exact identity of which seems to be some-

[196] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:195 (1909).

what in doubt.[197] It is one of the trees known in the Guianas as "kakaralli," and occurs plentifully in Surinam, where the present limited commercial supply of this wood is obtained. The tree is tall, reaching a height of over 100 feet and a diameter of from three to four feet near the ground. Logs can be had from 30 to 50 feet in length and up to 28 inches square, free of sap. The trunks are generally tall, straight, cylindrical, and free of branches for more than one-half of the total height of the tree.

"Manbarklak" is considered equal to greenheart (*Nectandra Rodioei* Schomb.), and it has been frequently recommended for maritime work. A test specimen of piling placed in a jetty at Flushing, Holland, in 1885, gave such satisfactory service that the timber was ranked second on the list of Surinam woods resistant to seaworms. In 1900 a firm in Holland began to import logs of this wood, but it was found so difficult to secure timber according to specifications, and so expensive to get the heavy material out of the forest that the operators soon found it impossible to compete with greenheart from Demerara.

Piles of "manbarklak" supporting the railway bridge across the Saramacca Canal at Beekhuizen, Surinam, were placed in use in March, 1904, and removed in March, 1921, and after 17 years' service were perfectly sound and fit for further use. The *Neoteredo*, the most destructive of shipworms, infests the waters of this canal, but did not attack this wood at all, though a piece of Demerara greenheart placed in the water of this canal in February, 1920, was found upon removal in May, 1921, to be completely riddled. The only damage to the "manbarklak" was a slight superficial injury from marine stone-borers (*Martesia cuneiformis* Say.).[198]

THE WOOD

? *Eschweilera corrugata* Miers — *Manbarklak.*

Common names: Manbarklak (Sur.); kakaralli (variously spelled), black kakaralli, wena (B. G.). Other species of Eschweilera and of Jugastrum: Matamatá, matá-matá, páo de macaco, ibiribá-rána, castanheira das aguas, macacarecuya, biriba, biribi (Braz.); naranjillo (Venez.); mahagua de Indio (Pan.); toledo wood ?.

General properties: Color olive-brown or reddish-brown, somewhat

197 Mr. Gonggrijp, forester of Surinam, refers it to *Eschweilera longipes* Miers (= *Lecythis longipes* Poit.), but according to Miers' description (*loc. cit.*, p. 254) this species is a small tree only 25 to 30 feet high. It is variously referred by other writers to *Lecythis ollaria* L., *Eschweilera corrugata* Miers (= *L. corrugata* Poit.), and to *Chytroma.* See also *Journ. Bd. Agr. Brit. Guiana,* 15: 4: 198, Oct., 1922.

198 From data and specimens of the timbers supplied by Mr. J. W. Gonggrijp, forester of Surinam. See also Gonggrijp: Over Demerara greenheart, manbarklak, en een nieuwe tegen paalworm bestande houtsoort, *West Indie,* Sept., 1921.

streaked with lighter or darker shades; not highly lustrous. Sapwood lighter. Odor and taste absent or not distinctive.

Extremely hard, heavy, and compact. Sp. gr. (air-dry) 1.21. Weight about 76 lbs. per cu. ft. Grain straight. Texture rather fine. Wood hard to cut, easy to split, very tough and strong, breaking with long splintery fracture; takes high polish; apparently immune to attack of shipworms.

Growth rings: Present, but not always distinct; due to the wider spacing at intervals of some of the parenchyma lines.

Parenchyma: In very numerous, very fine, concentric lines independent of pores; one to three cells wide; barely visible without lens; becoming crowded toward the outer portions of the growth rings. Some pith-flecks noted.

Pores: Small, but very distinct, appearing as white dots on darker background; all closed; not very numerous; occurring singly or more often in radial groups of two to several; sometimes showing diagonal arrangement.

Vessel lines: Fine, but distinct in proper light, appearing lighter than background; long and straight.

Vessel contents: Tyloses abundant, completely filling vessels.

Rays: Extremely fine; visible with lens on cross section, but not on tangential; distinct, but not conspicuous, on radial surface, where they appear somewhat darker than background; one or two cells wide, mostly uniseriate, and few to 50 cells high.

Ripple marks: Absent.

Gum ducts: Large vertical ducts of gummosis type occasionally found resembling the so-called "gum veins" in the *Eucalyptus*.

Remarks: Wood somewhat denser than "matamatá." The wood of *Eschweilera panamensis* Pittier (Yale No. 2976; Pittier's No. 4338) has fewer, smaller, and much less distinct pores and the parenchyma lines are finer and somewhat more closely spaced; otherwise much as in preceding.

Material: Yale Nos. 4164, 4196, 4956 (Surinam), supplied by Gonggrijp.

COURATARI

Couratari consists of eight species, according to Miers (*loc. cit.*), who transferred to *Cariniana* several species commonly included in this genus. The fruits of the two genera are much alike, being a woody capsule (*pyxidium*) resembling a large pipe-bowl, with a stopper-like plug chamfered on three sides to provide space for the winged seeds which are attached to it, the outer end (operculum) closing the opening. When the fruit is ripe this plug falls out and liberates the seeds. In *Couratari* proper the wing completely surrounds the embryonic disc in the center, somewhat as in elm (*Ulmus*), only much larger (one to three inches, longest diameter); in *Cariniana*, on the other hand, the wing is at one end, as in the case of maple (*Acer*) and mahogany (*Swietenia*).

The following notes are from Miers (*loc. cit.*, pp. 280-284): *C. glabra* Camb. is a tree 20 to 30 feet high in the forests of Rio de Janeiro. *C.*

rufescens Camb., of the same region, is "a noble tree, with a straight trunk 40 to 60 feet high, with a wide-spreading head." *C. Tauari* Berg. of Pará, is "a magnificent tree, with a straight trunk, strengthened at its base by strong buttresses, and affords a valuable hard timber of a palish color, used in ship-building, yields logs 65 feet long and 18 inches square. The name 'tauari' is also given to its laminated inner bark, consisting of many thin whitish sheets of the substance of paper, well-known in commerce, being extensively used for the covering of cigarettes." *C. guianensis* Aubl. of Guiana is "a tree of immense size, growing on the borders of rivers, with a straight trunk 60 feet long and four feet in diameter, affording an excellent timber; and its inner bark, composed of several scores of laminae, is applied to many useful purposes." The common names of this species as given by Stone[199] and others are: Couratari, kouratary, balalaboué, caouroubara, balata blanc, bourrao, maou, maho or mahot couratari, maho fer (Fr. G.); ingipipa (Sur.).

CARINIANA

The species included in this genus are usually referred to *Couratari.* Miers says (*loc. cit.*, pp. 169-170): "*Cariniana,* however, is a valid genus, containing several species, all trees of noble proportions, mostly from 100 to 120 feet in height, with gigantic trunks, often spreading out in large buttresses. The species, some of which are known only by their fruits, extend from Central Brazil to the Amazonas region, one being known from Trinidad. The leaves vary much in size in the several species, in some one inch long, in others more than a foot in length, but the inflorescence, more constant in character, is peculiar, always in wide-spreading, very slender panicles, charged with numerous flowers which are minute compared with those of all other Lecythidaceae. . . . The pyxidium has the trigonoidly cylindrical or obconical form of that of *Couratari,* but it is much thicker, heavier, and more solid in substance. . . . The seeds, though winged, are very different from those of *Couratari;* the wing is much narrower and placed at one end only of the much shorter embryoniferous escutcheon, equal to it in width."

According to the same authority (pp. 288-289), *Cariniana rubra* Miers (= *Couratari rubra* Gardn.) is "a large tree, with an inflorescence greatly resembling that of *C. uahupensis,* but with very different leaves and different fruit; the latter is called 'cachimbo de macaco'" (monkey's pipe). *C. uahupensis* Miers (= *Couratari uaupensis* Berg. = *Amphoricarpus uaupensis* Spruce) is "a tree of vast size, with a

[199] Stone, Herbert: Les bois utiles de la Guyane française, *Ann. Mus. Col. de Marseille,* 6:2:22-23 (1918).

trunk 100 feet high, five feet in diameter, strengthened at its base by projecting buttresses, and called 'chorão' and 'choro' by the natives, signifying magnificent." *C. exigua* Miers is "a tree 60 feet high, apparently first discovered by Purdie, and now cultivated in the Botanic Garden of Trinidad."

The "albarco" or so-called Colombian mahogany, *Cariniana pyriformis* Miers, is the only timber of the Lecythidaceae which has figured to any appreciable extent in the export trade. Although common in the Maracaibo region of Venezuela, where it is known as "bacú," the timber has been exported only from Colombia; it entered the foreign market about 45 years ago, the early shipments being principally to France. Selected material has a beautiful appearance when finished, the color, luster, and grain rather closely resembling the genuine mahogany (*Swietenia*).

In 1911 the U. S. Forest Service published a detailed report[200] on this timber, from which the following is quoted (p. 8): "While *Cariniana* differs widely in its botanical and anatomical characters from true mahogany, its close superficial resemblance to mahogany and its physical properties at once distinguish it as a high-class cabinetwood. . . . When properly seasoned it does not warp, check, or shrink, while much of the lumber is beautifully figured. It works well, takes a filler readily, and can be highly polished. There is no reason why it should not be employed for all purposes for which true mahogany is used. The wood is hard, heavy (42 pounds to the cubic foot, with a specific gravity of 0.674), strong, and tough, and in color and weight compares almost exactly with genuine mahogany. Those who work *Cariniana* wood observe that it dulls the saws and other tools very quickly, a fact which first cast suspicion on it as not being real mahogany and led to its study by the Forest Service."

Mr. Curran says: "The 'albarco' is one of the most common trees in the forests of northern Colombia at elevations of from 200 to 2000 feet above the sea, the best stands lying between 500 and 1000 feet. It is confined to the lower slopes and well-watered valleys, and does not extend into the flood plains except occasionally in the better drained areas. Over much of the region lying between the Cauca and Magdalena Rivers it may be considered one of the principal timbers, if not the one supplying the bulk of the cut. The bark is of a very fibrous nature and is used by the natives for rough cordage. The wood is known on the local markets, but on account of a plentiful supply of more accessible timbers, it is little used. The claim of certain mill men in the United

[200] Sudworth, George B., and C. D. Mell: *"Colombian mahogany,"* Cir. 185, U. S. Forest Service, Washington, D. C.

States that this wood dulls the saws and other tools very quickly has not been borne out in my own experience and it seems likely that there are differences in the quality of the timber in this respect, depending upon the particular locality of growth or other factors not yet determined. Since this timber exists in large quantity where it can be readily logged, efforts to use it should not be abandoned until it is conclusively shown that the alleged difficulties in working are real and cannot be overcome."

The wood has a structure very similar to that of the Brazilian "jequitibá," but is generally heavier, of higher luster, and more highly figured, being often roe-grained. The heartwood is purplish-brown, fading somewhat upon exposure; the thick sapwood is of an oatmeal color and is not very sharply defined. The presence of the numerous, fine, closely and usually evenly spaced, concentric lines of wood parenchyma is sufficient to separate this wood from those of the mahogany family (*Meliaceae*). *Material:* Yale Nos. 414*, 500, 3968* (Col.); 6346*, 6348* (Venez.). Asterisk indicates botanical material.

Corresponding closely to the Colombian mahogany is the Brazilian "jequitibá," a name applied to at least three species of *Cariniana*. According to Miers (*loc. cit.*, pp. 285-287), *Cariniana excelsa* Casar (= *Couratari estrellensis* Roddi) "is a tree with a trunk of immense diameter, and 120 feet high, not infrequent in the Province of Rio de Janeiro, affording a valuable timber, and bearing the name 'jequitibá branca,' which is much employed in the campos for sugar-cases." *C. domestica* Miers (= *Couratari domestica* Mart.) "is a lofty tree, bearing the name of 'jequitibá,' known to occur in the province of Goyaz, Brazil." *C. brasiliensis* Casar (= *Couratari legalis* Mart.) of Rio de Janeiro "is a tree of immense size, with very broad, lofty, spreading branches, its trunk producing a timber of much value, useful in works of construction and shipbuilding, which is known by the name of 'jequitibá rosa.'"

Mr. Curran supplies the following notes regarding "jequitibá": "These trees are the giants of the Brazilian forests, especially in the coast region and São Paulo, and are said to reach heights upward of 200 feet with diameters of eight to ten feet, though the largest I have seen were about 125 feet high with well-formed trunks free of branches for 60 to 80 feet, and three or four feet through. The trees occur in mixtures with other hardwoods, but are a constant factor over vast areas. The fruits are about three inches long, urn-shaped, and used by the natives for pipe bowls. The wood is well known in Brazil and used locally for interior construction, though it is not on the market in quantity. It is light brown, easily worked, and gives promise of becom-

ing one of the most important timbers of South America for general construction and carpentry." Various botanical specimens from Brazil have been identified as *Cariniana legalis* (Mart.) Kuntze.

THE WOOD

Cariniana legalis (Mart.) Kuntze — *Jequitibá.*

Common names: Jequitibá, jequitibá amarella, jequitibá branca, jequitibá rosa, jequitibá vermelha (Braz.); Brazilian mahogany.

General properties: Color light reddish or pinkish-brown, with or without darker streaks, to deep reddish-brown; not highly lustrous. Sapwood lighter; not always sharply defined.

Odor and taste absent or not distinctive.

Rather light and soft to medium hard and heavy. Sp. gr. 0.50 to 0.70. Weight 31 to 43 lbs. per cu. ft. Grain straight or fairly so. Texture moderately fine. Wood easy to cut, not harsh, sometimes woolly in softer specimens; finishes smoothly; is tough and strong for its weight; harder kinds tend to split in nailing; dark-colored material looks durable.

Growth rings: Fairly distinct to indistinct, due to slight differences in color and in density.

Parenchyma: In very numerous fine, closely and fairly uniformly spaced, finely wavy concentric lines, of same width as the rays or slightly wider; visible, but inconspicuous and sometimes indistinct; layered effect on tangential surface may be fairly distinct.

Pores: Small to medium; readily visible; numerous to fairly so; fairly well distributed; occurring singly or in radially subdivided groups. In some specimens the pores are larger and more numerous in early wood of growth ring.

Vessel lines: As long, rather deep scratches; not conspicuous.

Vessel contents: Tyloses few to abundant.

Rays: Fine; faintly visible to fairly distinct on cross and tangential sections; very distinct on radial surface, where they appear darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Much like the "albarco" of Colombia. "Jequitibá branca" (Yale Nos. 3160, 3276, 3203) has similar structure, but the wood is lighter-colored, somewhat coarser-textured and the sawn surface is decidedly woolly.

Material: Yale Nos. 1466, 3159, 3203, 3276*, 3289*, 3524, 3560, 3901, 3942*, 4266, 4699* (Braz.). Asterisk indicates botanical material.

ALLANTOMA

This genus, established by Miers, includes several species, "some (probably all) vast trees, with the habit and inflorescence of *Couratari.*" The name, derived from the Greek, refers to the sausage-like form of the fruit, which is rather long and cylindrical, and of the same gen-

eral type as that of *Cariniana* and *Couratari*. The seeds, according to Miers (*loc. cit.*, p. 171), "are few, arranged imbricatively, and fixed to the columella by a basal hilum; they are linearly oblong, thickish, somewhat flattened on the anterior and posterior faces, acute and much jagged on the straight margins, have a dark or reddish color, are rough behind, corrugate tuberculous in front, unequally 2-lobed at the base." The kernel is of an "opaque white color; and when boiled in water or soaked in that fluid for a few days, it becomes as soft as a custard, but is again consolidated by drying."

There are no authentic specimens of the wood of this genus available, and little information, other than the botanical descriptions, has apparently been published. *Allantoma torulosa* Miers is one of the "monkey-pot" trees of Pará. *A. cylindrica* Miers, of the same country, has seeds that are good to eat and the fruit is called "castanheira da serra" by the natives, and skittle-nut by the English.

GRIAS

The four known species of this genus are slender trees, the largest rarely exceeding 50 feet in height[201] and a foot in diameter, with comparatively small flowers, and with extremely large leaves sometimes three feet long. The edible fruit is globular or pear-shaped, of a green or russet color, and contains one to four seeds. The wood of *Grias Aubletiana* Miers (= *Gustavia tetrapetala* Aubl.) is said to have a fetid odor.

Grias Fendleri Seem. was discovered originally in 1850 by Fendler in the forests near the mouth of the Chagres River in Panama and was not collected again for 60 years, this time by Pittier in southern Darien, where it is known to the natives as "membrillo macho." It is a tree 25 to 40 feet high, with a trunk about a foot in diameter divided almost from the base and covered with a smooth gray bark. The yellowish wood is moderately hard, straight-grained, and easy to work. The pores are small, numerous, usually arranged in little irregular groups or short radial rows of two to five pores each. The parenchyma is in exceedingly numerous, fine, wavy, tangential lines, one cell wide, extending between the rays. The rays are five to eight cells wide and many cells high; heterogeneous; distinct on cross section and very conspicuous on radial surface, where they produce a pronounced silver grain. The fibers are very long and slender, and have thick walls and minute cavities.

201 Miers (*loc. cit.*, p. 172) characterizes them as "very lofty trees," but there is nothing to indicate this in the dimensions he gives in the descriptions of the species (pp. 299-301).

60. RHIZOPHORACEAE

The Mangrove Family consists of 15 genera and about 50 species, mostly large shrubs or small trees, of tropical and sub-tropical regions. One tribe, the Rhizophorae, is confined to the tidal marshes, where they form evergreen thickets or forests binding together the mud and gradually building up the land area, while the other, the Legnotidae, occurs in the uplands and the dry interior.

The woods of these two groups are very distinct. In the first or mangrove tribe, wood parenchyma is scanty, the rays are all fine, the wood fibers have simple pits, and the vessels have scalariform perforations throughout, usually with few bars. In the dry-land tribe, wood parenchyma is more abundant and sometimes very prominent, the rays are often of two kinds (very small and very large), as in the Proteaceae, the wood fibers have bordered pits, and the vessel perforations are simple, except possibly in regions adjoining the pith. Two genera, one of each group, occur in tropical America, but the only one of commercial value is *Rhizophora.*

RHIZOPHORA

The several species of this genus are all very much alike, being evergreen trees or shrubs with peculiar stilt-like roots growing in tideland marshes and often forming impenetrable barriers along the low muddy shores and sometimes extending into the sea as far as low-water mark. The red mangrove, *Rhizophora Mangle* L., is found in southern Florida, the West Indies, the west coast of Mexico, lower California, and from Central America along the northern coast of South America to Brazil; also on the west coast of Africa and the islands of the Pacific.

In parts of northern South America there are very extensive mangrove swamps at the mouths of all the great rivers and fringing the coast in certain places. The accessible stands in Venezuela have been seriously depleted and the forests about Lake Maracaibo now produce only small-sized poles for fencing, house construction, and firewood, while those of Porto Cabello have been practically destroyed and are now areas of low scrubby growth. On the deeper soils, muddy banks, and islands of the Orinoco delta, however, there are pure stands of red mangrove still in virgin condition. The tree reaches a height of 100 feet with diameters up to three feet, though the usual commercial sizes are less than 24 inches through, with clear lengths of 30 to 40 feet.

The mangrove is used extensively in Ecuador because of its accessibility. Owing to the tendency of the lumber to check and warp, the logs are usually stored in water and sawed only as needed. The timber is

Cross Section of Monkey-pot Wood from Panama (x 50).
(*Lecythis ampla.*)

Photo by H. M. Curran.

Tangle of Aerial Roots in Mangrove Swamp, Venezuela.
(*Rhizophora Mangle.*)

used for rafters, scantling, beams, joists, braces, knees and ribs of boats, and miscellaneous construction, and also for posts, piling, railway ties, charcoal, and fuel.

The size and extent of the mangrove forests of Brazil are variously reported. It is said that there are large areas near the mouth of the Amazon, but neither the wood nor the bark is utilized extensively.

The stem of the red mangrove is supported, often ten feet or more above the ground, on great masses of stilt-like aerial roots, occupying an area sometimes 30 feet in diameter. Another peculiarity of the tree is its method of propagation. The seed, while still attached to the tree, develops a radicle about twice as thick as a lead pencil and from one to two feet in length, which, when detached, falls like a dart and sticks upright in the mud ready to put forth leaves and roots immediately; some are carried away by the ebbing tides and float upright until they reach the soil, so that every newly formed mud bar or island is soon taken possession of by natural plantations of mangrove seedlings.

The chief value of the tree is not for its wood, but for its bark, which yields from 20 to 30 per cent of tannin and supplies a very important article of commerce. This is shipped in a natural state or in the form of extract, and is used for tanning, dyeing, and to limited extent for medicine. Colombia exports large quantities of the extract, but most of the material produced in Venezuela is for local consumption. In securing the bark the wood is commonly wasted. (Plate XII.)

THE WOOD

Rhizophora Mangle L. *Mangrove.*

Common names: Mangrove, red mangrove (Eng.); manglé, m. colorado (Span. Am., gen.); manglé rouge (Guad.); manglíer (Mart.); manglíer rouge (Trin.); mangue vermelho, mepareyba, apareiba, guapariba (Braz.); paletuvier rouge (Fr. G.); duizenbeenboom (Sur.); manglé salado (Pan.); manglé gateador (C. R.); candelón, manglé dulce, m. tinto, tab-ché, tap-ché (Mex.).

General properties: The color is a dull red or reddish-brown, sometimes purplish; uniform or with darker stripes. Sapwood rather thick, grayish; usually, but not always, sharply defined.

Odor and taste absent or not distinctive.

Wood very hard and heavy. Sp. gr. (oven-dry) 1.16 (Tenth Census). Weight about 72 lbs. per cu. ft. Grain variable from straight to very irregular. Texture fine. Wood hard to cut, rather harsh and splintery, takes a good polish; strong and durable.

Growth rings: Present, but not very clearly defined; due to zones deficient in pores.

Parenchyma: About pores, but indistinct even with lens.

Pores: Very small, but usually visible as fine light-colored dots, especially in darker portions; closed; fairly well distributed, though with tendency to form irregular concentric zones; occurring singly or in radial groups of two to several.

Vessel lines: Fine and indistinct. Vessel perforations are scalariform with few thick bars which can be seen with good hand lens on radial section.

Vessel contents: Tyloses abundant.

Rays: Very fine; scarcely visible on cross section; invisible on tangential; very distinct on radial, where they are somewhat darker than background and occupy most of the surface.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: This wood seems identical in appearance and structure with a specimen of mangrove from Nigeria (Yale No. 4512).

Material: Yale Nos. 5220*, 5221* (Florida); 2188 (Cuba); 2134*, 2136* (Curaçao). Asterisk indicates botanical material.

61. COMBRETACEAE (TERMINALIACEAE)

The White Mangrove Family consists of 15 genera, very widely distributed throughout the tropical and sub-tropical regions of the world. Many of the genera contain trees, some of which are large and important, particularly in the Old World. According to Gamble[202] the family is of great value to the Indian forester, "containing as it does some of the most important and widely distributed of the trees of India, valuable not only for their timber and products, but for their influence on the silviculture of the forests." Plants of this family supply also bark, leaves, and fruits used extensively in the tanning and dyeing industries and also to some extent for medicinal purposes.

TERMINALIA

This genus, the most important in the family, contains over 200 species, and is well represented throughout tropical and sub-tropical regions generally. In India, according to Gamble (*loc. cit.*), there are 16 species, mostly important trees of large size, valuable for their timber or as producers of tanning material. "It is possible that there is no tree in the Indian forests so widely distributed, so common and so important for the supply of the requirements of the agricultural population as is *Terminalia tomentosa.*" *T. Chebula* Ritz supplies the myrobalan nuts of commerce, used extensively for tanning and dyeing. *T. Catappa* L. has been widely planted in tropical America for shade and decorative purposes, and is commonly known as "almendro," "almendron," or

[202] Gamble, J. S.: *A manual of Indian timbers,* London, 1902, p. 336.

"almendrillo"; its wood is rather hard, open-textured, and has a general resemblance to mahogany. There are two or three species producing woods of some commercial importance in the Philippines and used for general construction, interior finish, and for furniture. There are many species in tropical Africa.

The woods of *Terminalia* are at present of only local importance in tropical America, but they have many good qualities, and in places timbers are available in sufficient size and abundance to justify more extended use for railway ties, general construction, and furniture. The woods of the genus exhibit great variation in their appearance and structure. In color they may be gray, yellow, brown, red, or nearly black, often variegated or striped, and sometimes with a satiny luster. The pores in some instances are very small and inconspicuous, in others they are comparatively large and distinct. Parenchyma is associated with the pores, sometimes joining into irregular lines, sometimes in fairly regular tangential lines or bands, but usually without sufficient contrast in color to be conspicuous. The rays are very fine and often invisible or indistinct on cross and tangential sections, but may produce a fine silver grain on the radial. Vertical gum ducts in peripheral rows or arcs have been observed in several species, but are not of normal occurrence. Taking the group as a whole one can find in it woods suggesting elm, walnut, teak, and mahogany, while others appear related to the Lauraceae. They suggest the Leguminosae in certain structural details, such as arrangement of parenchyma, exclusively simple perforations of the vessel segments, and sieve-like perforations of the pit membranes; but the general appearance is usually quite distinct.

West Indies and Central America. Terminalia Buceras Bail. (= *Bucida Buceras* L.) is the only species occurring in the United States, and that only on Elliott's Key in Florida, where it is known as black olive tree. According to Sargent[203] this is a tree with a single straight trunk, or often with a short prostrate stem two to three feet in diameter, producing several straight upright secondary stems 40 to 50 feet high and 12 to 18 inches in diameter. The species is widely distributed in brackish marshes through the West Indies to the shores of the Caribbean Sea and the Bay of Panama. This, and closely related species, are known as the "júcaro" in Cuba, where on low and wet lands in certain areas the trees are abundant enough to produce a distinct type in the transition zone between the savanna and the upland forest. In the very wet places the tree is short and scrubby, but on the better aerated soils it has the general appearance of elm (*Ulmus*) and attains a height of 70 feet,

203 SARGENT, C. S.: *Manual of the trees of North America*, 1922, p. 765.

with 30 to 40 feet clear of limbs and a diameter up to 26 inches. On well-drained soil it disappears or is scattered. The wood is used locally for poles, posts, cross-ties, piling, vehicles, sills, wharves, and general carpentry and construction, where strength and durability are essentials. Common names: Black olive tree (Fla.); júcaro, júcaro de playa (Cuba); búcaro, ucar (P. R.); pucté, pukté (Mex.).

There is a species of *Terminalia* that is very common in the rain forest of the Guatemala-Honduras region and produces tall symmetrical trees up to 110 feet in height, with a merchantable length of 60 feet and a diameter up to four feet. It is known as "naranjo," and the wood has considerable local use for general construction and railway ties, though it is not esteemed very highly for the latter purpose. It is not now exported, but may enter the market as a medium-priced wood for furniture, interior finish, and general carpentry.

THE WOOD

Terminalia sp. *Naranjo.*

Common names: Naranjo, boladora (Guat.-Hond.).

General properties: Color lustrous light gray or yellowish, becoming decidedly yellowish upon exposure; injured portions red or brown. Specimens available indicate no distinction between heart and sapwood.

Taste slightly astringent. Odor absent or not distinctive.

Wood moderately hard and heavy. Sp. gr. (air-dry) 0.65 to 0.75. Weight 40 to 47 lbs. per cu. ft. Grain variable from straight to roey or curly. Texture medium. Wood easy to cut, takes a good polish, is stiff and strong, but apparently not very durable.

Growth rings: Absent or poorly defined by irregular poreless zones and rarely by an indistinct line of terminal parenchyma.

Parenchyma: In narrow, mostly indistinct circles about the pores, sometimes extending wing-like and becoming confluent; sometimes also in concentric lines apparently limiting growth rings; not conspicuous on any surface.

Pores: Small, but readily visible; numerous, but not crowded; fairly well distributed; occurring singly or in groups, as though subdivided radially two to six times; open.

Vessel lines: Appearing as rather deep scratches; distinct in proper light.

Vessel contents: Some reddish gum deposits observed.

Rays: Very fine; barely visible on cross section; mostly invisible on tangential; distinct on radial surface in proper light, producing a fine silver grain.

Ripple marks: Absent.

Gum ducts: Observed in one specimen near injury; gummosis type; contents reddish.

Minute anatomy: Vessels with simple perforations; inter-vascular pits

rather large, crowded; pit membranes dotted. Rays coarse-celled; more or less heterogeneous; uniseriate and one to 15 (rarely more) cells high; pits into vessels half-bordered. Parenchyma common; cells coarse. Fibers with simple pits; some are septate.

Remarks: This wood has the general appearance and luster of certain of the Lauraceae.

Material: Yale Nos. 3678, 3695, and 3709 collected with leaves and fruits along Guatemala-Honduras boundary by Whitford and Stadmiller.

South America. There are many species of *Terminalia* in South America, but little information is available concerning them. The two best known in Argentina are the "amarillo," *T. australis* Camb., and the "guayabí," *T. triflora* Gris. They are small trees supplying some timber for miscellaneous purposes requiring a strong material. Two large trees of the lower Amazon are the "cuirana," *T. Tanibouca* Smith, and the "mirindiba," *T. lucida* Hoffm. Species of *Terminalia* supply important timber for local uses in Trinidad.

A species known as "araçá," identified as *T.* aff. *januarensis* DC., is a common tree along the lower slopes and valleys of the east coast region of Bahia, where it grows in almost pure stands or makes up a large part of the forest over considerable areas. It attains a height of 100 feet, with clear lengths of 50 to 60 feet and a diameter of three or four feet above the widespreading buttresses. It is conspicuous in the forest because of its peculiar shape and smooth, thin bark, suggesting *Eucalyptus*. Although the wood is used locally, there is no special market for it at present. It is suitable for many of the purposes for which we use birch and maple.

THE WOOD

Terminalia aff. *januarensis* DC. *Araçá.*

Common names: Araçá, araçá de agua, merendyba-bagre (Braz.). OTHER SPECIES: Merendyba, mirindiba, amarilho, cuiarana, amendoeira, cachaporra do gentio, guarajuba (Braz.); guayaba león (Col.); amandier du bord de mer, amandier du pays, almendrón de playa, olivier, yellow olivier, aceitunillo, poirier (Trin.); amarillo, amarillo del río, lapachillo, guayabí sayyú, g. amarillo, guayaybí-rá, guayabil amarillo, lanza amarilla, palo amarillo (Arg.); tanibouca, nagosse, nagossi, nangocy, langoussi (Fr. G.); coffee-mortar, naharu (B. G.).

General properties: Color yellowish or yellow-brown; sometimes beautifully mottled with black, according to Curran; lustrous. Sapwood brownish or grayish; not sharply defined.

Taste mildly unpleasant; somewhat astringent. No distinct odor.

Wood rather hard and heavy. Sp. gr. (air-dry) 0.77. Weight about 48 lbs. per cu. ft. Grain straight. Texture rather fine. Wood suggests birch in density, texture, and working properties; does not appear durable.

Growth rings: Present, due to poreless zones, presence of parenchyma lines or to both combined; sometimes fairly distinct on tangential surface.

Parenchyma: In fine circles about pores and often connecting them tangentially or diagonally; also in occasional fine lines independent of the pores.

Pores: Small, but visible; very numerous; occurring singly or in radial groups of few to several pores; often joined by parenchyma into arrangement suggesting elm.

Vessel lines: Fine and inconspicuous; appearing as long scratches.

Vessel contents: None observed.

Rays: Very fine; faintly visible on cross section, but not on tangential; distinct, but not conspicuous, on radial, being of same color as or slightly darker than background.

Ripple marks: Absent. On tangential section, by means of a good lens, the cells of the unisieriate rays are large enough to be faintly seen and they are so uniform in height and the rays are so close together that extremely fine striations are produced, several hundred per inch.

Gum ducts: Present; presumably traumatic; in single arcs or circles filled with gum; small, but distinct on all sections.

Remarks: Suggests some of the harder and finer-textured woods of the Lauraceae. The name "araçá" is more commonly applied to woods of the Myrtaceae, because of the similarity in appearance of the trees in the forest.

Material: Yale Nos. 3940, 4709; collected by Curran in Bahia, Brazil.

MISCELLANEOUS

Buchenavia capitata (Vahl.) Eichl., known as "granadillo" in Porto Rico and yellow sanders in the British West Indies, attains a height of 80 feet and a diameter of three feet. The yellowish wood is moderately hard, often wavy-grained, and takes a beautiful satiny polish. It is used for furniture and cabinetwork.

Conocarpus erecta L. occurs in low muddy tide-water shores of lagoons and bays in southern Florida, the West Indies, Central America, and tropical South America, and the west coast of Africa. It varies in size from a low shrub to a tree 60 feet high and 30 inches in diameter. The wood is fine-textured, heavy, hard, and strong; used locally for fuel and for charcoal and rarely for construction purposes. The bark contains considerable tannin. Common names for this tree are: Buttonwood (Fla.); manglé botón, yana (Cuba); manglé, m. botón, m. botoncillo, m. colorado (P. R.), manglé (S. D.); grignon (Fr. G.); paletuvier (Guad.); manglé roche, m. botoncillo (Trin.); botoncillo, manglé botoncillo (Venez.); zaragoza (Col.); manglé piñuelo (Pan.); botoncillo, manglé, m. negro, m. prieto (Mex.). *Material:* Yale Nos. 2790* (Curaçao); 5194*, 5195* (Florida); 4865*, 4871* (Haiti). Asterisk indicates botanical material.

Laguncularia racemosa Gaertn. inhabits muddy tidal shores of bays and lagoons in southern Florida, the West Indies, tropical Mexico, Central America, tropical South America, and western Africa. It varies in size from a low shrub to a tree rarely 60 feet high and 20 inches in diameter, with a round-topped crown. The wood is rather heavy, hard, and strong, and is sometimes used locally for fuel. The bark is rich in tannin and is occasionally employed in tanning and for medicinal purposes. The common names for this tree are: Buttonwood, white buttonwood, white mangrove (Fla.); manglé blanco, m. bobo (P. R.); white mangrove, bastard buttonwood, green turtle bough (Bah.); manglé prieto (S. D.); manglé amarillo, patabán (Cuba); manglé blanc (Guad.); mangue branco, tinteira (Braz.); manglé blanco (Mex.). *Material:* Yale Nos. 5196 and 5197 (Florida).

62. MYRTACEAE

The Myrtle Family consists of over 70 genera and about 2800 species of trees and shrubs widely distributed throughout the tropical and subtropical regions of the world. Their representatives are, in general, characterized by an abundance of aromatic volatile oil, leaves that are usually simple, opposite, entire, and pellucid-punctate, and fruit that is baccate, few-seeded, and in many instances edible. To this family belong the myrtle, *Myrtus communis* L., a well-known aromatic shrub native to southern Europe and widely cultivated in gardens; the "pimento" or allspice tree, *Pimenta officinalis* Lindl., of the West Indies; *Eugenia aromatica* Baill. of the Molucca Islands, a tree whose dried flower-buds are the cloves of commerce; the rose apple, *Eugenia Jambos* L., of southeastern Asia, cultivated throughout the tropics as a shade tree and for its delicately fragrant fruit; and the "guava," *Psidium Guajava* Raddi, a tropical American tree extensively grown for its fruit, which is used largely for making jelly and other preserves. Other plants have beautiful flowers and are used for decorative purposes.

From the standpoint of timber production the most important genus is *Eucalyptus*, which makes up the bulk of the forests of Australia. There are about 200 known species, varying in size from small trees to the largest hardwoods in the world, and exhibiting an equally great range in the qualities and properties of their timber. Because of their rapid growth, many species have been planted on a commercial scale in California and in various parts of tropical America,[204] but the woods are mostly very hard and heavy, and difficult to season without serious

[204] See Navarro de Andrade, Edmundo e Octavio Vecchi: *Os Eucalyptos: Sua cultura e exploração*, São Paulo, Brazil, 1918.

warping and checking. This is the case particularly of the blue gum, *Eucalyptus globulus* Labill., the species most abundantly planted.

There are about 18 arborescent genera and several hundred species of this family growing naturally in tropical America, but their value lies in their fruits and various minor products, rather than in their timber. According to Huber[205] the family is represented in the Amazon region by hundreds of species, mostly all shrubs of the plains, banks of the rivers, and the understory of the forest. Besides the "goiabeira" (guava) and the "araçá do campo," *P. Araca* Raddi, the genus *Psidium* contains some forest trees of medium size, called "goiaba do matto" or "araçá do matto," which have smooth exfoliating bark and supply very heavy timber that is sometimes utilized. Certain species of *Eugenia* and *Myrcia* attain tree size and their compact wood appears suitable for turnery.

The family is abundantly represented in eastern and southern Brazil and in Argentina, particularly in the second-growth forests. While the woods are readily separable as a group, there are so many different kinds that it is not possible with our present limited knowledge to make specific or even generic distinctions within the group. The range of variation within the genus *Eugenia*, which contains over 500 species, seems to be greater than that between the woods of different genera. The woods as a whole are fine-textured, hard, tough, strong, and take a smooth finish, but they have a decided tendency to warp in drying and do not hold their place well under changing atmospheric conditions. They make excellent fuel, burning with much heat and little smoke, and are also used for handles, implement frames, and various purposes demanding a tough and strong material in small sizes or in the round. In a few cases the timber is good enough for general construction, and selected lumber is used to a minor extent for furniture and in vehicle construction. Taken as a whole, the woods are not durable in contact with the ground, but some of the red kinds are said to make satisfactory railway ties.

The color is variable. One kind in Argentina is a light gray streaked with black in a rather ornamental manner. The wood of the fruit-tree group is mostly rose-colored and often of very fine and uniform texture. The "murtas" and "araçás" of Brazil are mostly brown or reddish-brown, sometimes with a purplish hue. Because of their rather close resemblance in the forest, some of the trees of the Combretaceae are confused with those of the Myrtaceae and bear the same local names, as "araçá" in Brazil and "guayabo" in Colombia. Two common members

[205] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 196 (1909).

of this family in Bahia are known as "vassoura" and "baitinga," the latter being distinguished by the fact that the freshly exposed wood soon acquires a brilliant orange color, eventually becoming chocolate-brown on the surface. This wood is very hard, works readily, and is preferred by local carpenters for certain kinds of heavy and fairly durable construction. The "vassoura" is considerably softer than most of the woods of this family and becomes dark reddish-brown upon exposure. The name, meaning broom, refers to the clusters of fine twigs which characterize the tree, and is probably applied also to trees of other families.

Regarding the Chilean "luma," said to be *Myrtus Luma* Barn., Simmons[206] says: "From its properties and uses the 'luma' may be properly called the hickory of Chile. Noted for its hardness, strength, weight, and flexibility, it is called on most for tool handles, vehicle parts, gymnasium apparatus, etc. The wood burns long and with an intense heat and is therefore appreciated above any other tree for fuel purposes. Steamboats in south Chile demand it for this purpose in large quantities."

In the woods of the tropical American Myrtaceae the pores are mostly small, sometimes minute and evenly distributed, sometimes visible to the unaided eye and irregularly distributed or with a tendency to localize in patches or diagonal groups. Parenchyma is frequently in more or less distinct tangential or concentric arrangement, but is usually irregularly disposed and so merged into the background as often to be indistinct even under the lens; in some instances, particularly in the very fine-textured woods, it is difficult to distinguish any parenchyma at all. Growth rings are often present, but rarely are conspicuous or sharply defined. The rays are very fine and are not visible without the lens except on the radial surface, where they are low and inconspicuous. Ripple marks are absent. Gum ducts have not been observed in any of the American woods, but they are of common occurrence in *Eucalyptus* and have occasionally been found in other genera. (Plate XLVIII.)

The minute anatomy is not very distinctive. The vessels have simple perforations,[207] and where in contact with parenchyma the pits are mostly bordered. The rays are narrow and decidedly heterogeneous. The wood fibers are commonly thick-walled and provided with inconspicuously bordered pits.

Material: Yale Nos. 790 (Cuba); 354 (Venez.); 1539* (Col.); 5101,

206 Simmons, Roger E.: *Lumber markets of the west and north coasts of South America,* Special Agts., Ser. No. 117, Bu. For. and Dom. Com., Washington, D. C., 1916, p. 20.

207 The vessels of *Eugenia apiculata* DC. are said to have exclusively scalariform perforations.

5102 (B. G.); 1783, 1794*, 1796*, 1798, 1807*, 2502, 3241, 3245, 3261*, 3262*, 3391*, 3500*, 3547, 3635, 3646, 3654, 4682*, 4697* (Braz.); 1001, 1042, 1687, 1698, 1699*, 1712, 1715, 1757, 1775, 3976, 6217 (Arg.); 3753 (Chile). Asterisk indicates botanical material.

63. MELASTOMACEAE

The Meadow-beauty Family, consisting of about 150 genera and nearly 3000 species, is widely distributed in tropical regions and has the largest number of representatives in Brazil. Most of the members of it are under-shrubs, shrubs, and small trees, with occasional medium-sized trees of little economic importance. Arborescent genera found in tropical America include *Miconia*, *Calycogonium*, *Heterotrichum*, *Tibouchina*, *Henriettella*, *Bellucia*, and *Mouriria*.

The timber of *Miconia* is used for charcoal, fuel, fence posts, and to a limited extent for carpentry and small construction. The bark is sometimes used for tanning purposes. The names in general use are "camasey" (Span.), and "carvoeiro" and "jacatirão" (Port.). The wood is light brown, straight-grained, rather fine-textured, moderately heavy and strong, easy to work, and said to be fairly durable. The pores are small, but visible, not crowded, mostly in pairs, sometimes in radial rows; wood parenchyma absent or indistinct; rays extremely fine. *Material:* Yale Nos. 2979, 2981 (Pan.).

MOURIRIA

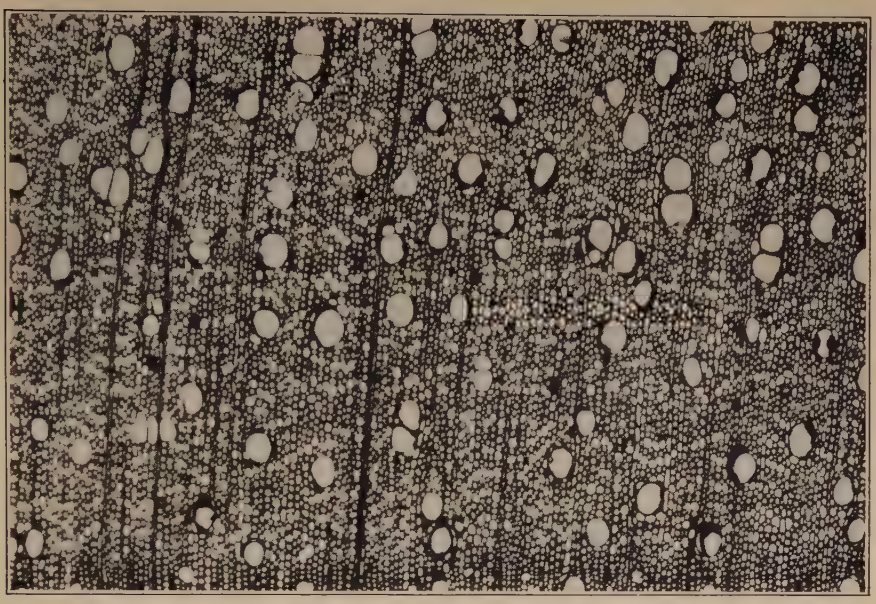
There are about 45 species of this genus, small to medium-sized trees, usually in the understory of the forest in Brazil, the Guianas, Venezuela, and the West Indies. The fruit has a decidedly sour taste and is sometimes used medicinally as an astringent.

The "pauji" of Venezuela, *Mouriria pseudo-geminata* Pittier, attains fairly large dimensions, with clear lengths of 25 feet and diameters up to 25 inches. The timber is used locally for beams and joists, to a limited extent for furniture, and also for fuel and charcoal; before the war logs of it were exported to Germany. The wood has an anomalous structure.

THE WOOD

Mouriria pseudo-geminata Pittier — *Pauji.*

Common names: Pauji, pata de pauji (Venez.). OTHER SPECIES: Yaya cimmarróna, yaya mansa, torcido, palo torcido, lebrero, mano de pilón (Cuba); murta, urury, tuncunaré merecá, apiranga, cafézinho, goyabarana, muriri (Braz.); yabe (Boliv.); bois fer (Fr. G.).



Cross Section of Guava Wood (x 50).
(*Psidium Guajava.*)

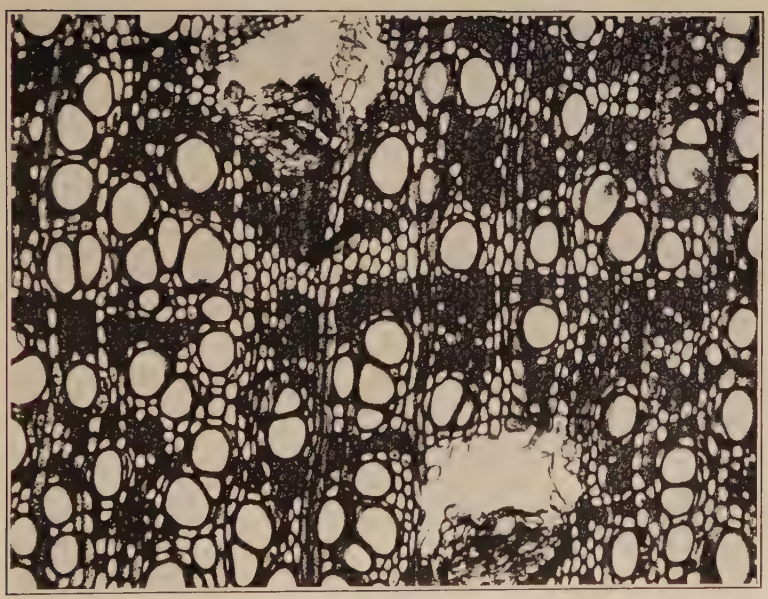


Photo by James Austin.

Cross Section of the Pauji of Venezuela, Showing Bast Cavities (x 50).
(*Mouriria pseudo-geminata.*)

General properties: Color a light, hoary yellow, grading into brown, with fine white lines of soft bast. Sapwood not clearly defined; yellowish. Dark brown streaks resembling "rust" streaks in hickory may arise as a result of injury.

Odor and taste absent or not distinctive.

Wood hard and heavy. Sp. gr. (oven-dry) 0.78. Weight about 50 lbs. per cu. ft. Grain fairly straight to somewhat roey. Texture medium. Wood easy to cut, takes good polish, is strong, but does not appear durable.

Growth rings: Poorly defined, due to zones deficient in pores and sometimes also to parenchyma.

Parenchyma: Fairly abundant, but not very distinct; gives hoary appearance to cross section; in short, irregular, tangential lines and sometimes in concentric zones, sometimes closely and sometimes widely spaced.

Pores: Very small; indistinct without lens; numerous; not evenly distributed; occurring in irregular radial lines and patches. The distinct white dots uniformly distributed over the section about $\frac{1}{32}$ inch apart are sections of the soft bast strands.

Vessel lines: Fine and indistinct. Bast strands show as distinct narrow white lines.

Vessel contents: None observed.

Rays: Very fine; barely visible on cross section; invisible on tangential; visible, but inconspicuous, on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; inter-vascular pits abundant, very small. Rays decidedly heterogeneous; one or two (rarely three) cells wide and up to 30 cells in height; gum deposits common; pits into vessels very small, half-bordered. Parenchyma fairly abundant, metatracheal and paratracheal. Wood fibers thick-walled, with very numerous distinctly bordered pits.

Remarks: The anomaly in the wood structure is of the *Strychnos* type. The occurrence of inter-xylary phloem appears to be characteristic of the four genera *Kibessia, Memecylon, Pternandra,* and *Mouriria.*

Material: Yale No. 4427 collected by Pittier in the forests of Guaremales, Carabobo, Venez.

64. ARALIACEAE

The Ginseng Family, consisting of about 50 genera and upward of 500 species of trees, shrubs, vines, and herbaceaous plants, is widely distributed in the tropics and to a lesser extent in north temperate regions. A fairly common representative in eastern United States is the Hercules club, *Aralia spinosa* L. It is a small prickly tree with large compound leaves and is often planted for decorative purposes. One of the best known of the native herbaceous plants is the ginseng, *Panax,* which is cultivated extensively for the roots, which are exported in con-

siderable quantity to China for medicinal purposes. The English ivy, *Hedera*, belongs to this family.

Although many of the representatives are trees, some of which are of large size, they are commonest in the Far East, and in no instance are of more than local importance. The woods, which are light-colored, yellowish or gray, often with a satiny luster, are very soft or sometimes moderately hard, and are usually rather coarse-textured. They are suitable only for common lumber, paper pulp, and matches. The pith is often very large and that of *Fatsia papyrifera* B. & H. is used for making the so-called rice paper employed for lithographic purposes and for the manufacture of artificial flowers.

There are several genera with arborescent species in tropical America among which are *Schefflera*, *Pentapanax*, *Gilibertia*, *Sciadodendron*, and *Didymopanax*. There is scant information available concerning most of them. They are mainly small trees or shrubs with soft woods of little economic value.

DIDYMOPANAX

Of the thirty or more species of this genus that have been described, the best known tree is *Didymopanax Morototoni* D. & P., which is sometimes 100 feet in height and over two feet in diameter. It is widely distributed throughout tropical America and is characteristic of the open forests, the edges of savannas, and old clearings. The light and soft wood is suitable for use in place of pine or spruce for general carpentry, interior construction, boxes, crating, shelving, paper pulp, and matchsticks. In the Amazon region the lumber is sometimes sold for "marupá" (*Simaruba*). A species in southern Brazil, known as "mandioqueira," is a large tree with a trunk 20 to 25 feet long and 24 to 32 inches in diameter. The wood (Yale No. 3164), which is somewhat finer in texture than that of the preceding species, is used to a considerable extent for carpentry, and especially for box boards. It holds nails well and boxes made of it will withstand rougher handling than those of white pine (*Pinus Strobus* L.).

THE WOOD

Didymopanax Morototoni (Aubl.) D. & P. *Yagrume.*

Common names: Yagrume, yagrume macho, grayume, grayume macho, grayumo, pana cimarróna, llagrume, llagrume macho (P. R.); cordovan (Cuba); bois batard-canon, lentille, higuerton (Trin.); bois canon batard, bois de Mai, bois de Saint-Jean (Fr. G.); morototó, parapará (Braz.); yarumo de savana (Venez.); ambai guazú (Arg.); mangabé, gorgoran (Pan.); pava (C. R.).

General properties: Light gray, sometimes with yellowish tinge; liable to blue sap stain; lustrous. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Rather light and soft, but firm; of about the consistency of alder (*Alnus*). Sp. gr. (air-dry) 0.45. Weight about 28 lbs. per cu. ft. Grain straight or fairly so. Texture rather coarse. Wood easy to work, rather brittle, not durable, lacks figure.

Growth rings: Not clearly defined; sometimes indicated by slight differences in density.

Parenchyma: Scattered cells; not visible.

Pores: Small, but visible; numerous, but usually not crowded; uniformly distributed; occurring singly or as though subdivided radially two to three times, or in small groups.

Vessel lines: Rather fine and inconspicuous.

Vessel contents: Some tyloses present.

Rays: Rather coarse and uniform; distinct on all sections; marginal cells usually larger than interior cells.

Ripple marks: Absent.

Gum ducts: Vertical canals in margin of pith and common in rays of the wood; may be more than one in a ray; often distinct with lens. Radial canals have also been noted in *Arthophyllum, Cheirodendron,* and *Heptapleurum.*[208]

Remarks: The vessel segments are often provided with an elongated, coarsely pitted appendage; the perforations may be simple, scalariform with several bars, reticulate, or composite; the pits are large, irregular, with conspicuous borders, even where in contact with parenchyma. (In *Cheirodendron* the pits are scalariform, but most of the perforations are simple.) The fibers are septate; average length 1.35 mm.

Material: Yale Nos. 1711* (Arg.); 2709, 4663 (P. R.); 2998*, 6748 (Pan.); 3726* (Guat.-Hond.). Asterisk indicates botanical material.

65. MYRSINACEAE

This family consists of about 30 genera and several hundred species of shrubs and small trees, widely distributed in tropical and sub-tropical regions of the world. A few kinds are cultivated for the beauty of their evergreen foliage and bright-colored fruits. *Aegiceras* is one of the mangroves of the Far East.

There are 10 or more arborescent genera in tropical America, but their woods, though sometimes of local value, are of no commercial importance. The "jacare do matto," *Cybianthus detergens* Mart., and the "garapacunta," *Conomorpha peruviana* C. DC., supply a limited amount of timber for construction, joinery, fuel, and charcoal in Brazil. *Wallenia laurifolia* Sw. has a hard, light brown wood used in Cuba for

[208] See Record, S. J.: Further notes on intercellular canals in dicotyledonous woods, *Journ. Forestry,* 19: 3: 256, Mch., 1921.

furniture and small articles requiring solid construction; it is known there as "casmagua," "camagua," "caumao," "caomao," and "guacamarí común."

ARDISIA

Ardisia (*Icarorea*), with over 200 species, is very widely distributed. One species, the marlberry, reaches southern Florida where it is a slender tree rarely over six inches in diameter and 25 feet high, with white bark, and a heavy, hard, fine-textured, rich brown wood with prominent medullary rays which give a beautiful figure to the radial surface. The woods of this and some of the other species in the West Indies and South America are sometimes used for furniture, cabinetwork, and construction. The common names are: Marlberry, dogberry, cherry (Fla.); mameyuelo, badula (P. R.); agracejo, agracejo de sabana (Cuba); icacoré-catinga (Braz.).

JACQUINIA

This American genus, which some botanists refer to the family Theophrastaceae, consists of about 40 species. One of these, known as joewood, joebush, or ironwood, *Jacquinia keyensis* Mez, has its northern limit in Florida, where it is a small tree rarely over 15 feet high and six or seven inches in diameter, with a hard, heavy, fine-textured and beautifully figured wood of little use because of the size of the material. Spruce[209] found *J. armillaris* Jacq. growing abundantly in the very dry region along the Pacific coast of Ecuador, where it reached a height of 30 feet. He says it is a beautiful tree, having "somewhat the aspect of a holly, from the dark green rigid, spiny-pointed leaves; but the flowers, which are very numerous, are of a deep vermilion and very sweet-scented; and they are succeeded by fruits resembling small oranges in color and shape, though uneatable and narcotic, and used by the natives for stupefying fish." The common name of this tree is "barbasco" in Peru and Trinidad. Other species occur in Curaçao and are known as "trompito" and "mata piskao."

RAPANEA (MYRSINE)

The range of this genus, which contains nearly 150 species of shrubs and trees, includes nearly all the warm regions of the world. The cape beech or "beukenhout" of South Africa, *Rapanea melanophleos* Mez (= *Myrsine melanophleos* R. Br.), reaches a height of 50 feet and a

[209] Spruce, Richard: *Notes of a botanist on the Amazon and Andes*, Vol. II, p. 318.

diameter of over two feet and supplies a highly figured wood in local demand for making furniture and vehicles. The muttonwood of East Australia, *R. variabilis* Mez (= *M. variabilis* R. Br.), is a tree 45 to 50 feet high and a foot or more in diameter, with an oak-figured wood suitable for furniture and cabinetwork, except that it is procurable only in small sizes.

Of the numerous American species, one, *R. guianensis* Aubl., reaches its northern limit in southern Florida, where it is only a shrub, though elsewhere in its range, which includes the West Indies and northern South America, it is sometimes a medium-sized tree. The various Brazilian species are commonly known as "capororoca" and some of the trees are from 45 to 60 feet high and upward of three feet in diameter, but their timber is little used except for charcoal.

Trees of this genus are common in Argentina where they are known generally as "canelon"; also "capororoca" or some variant of that name. They are sometimes 100 feet in height, with trunks two to four feet through. The bark is said to be rich in tannin. The timber is used to a considerable extent for general carpentry, cabinetwork, crates and boxes, construction, paper pulp, and for fuel.

THE WOOD

Rapanea laetevirens Mez — *Canelon.*

Common names: Canelon, palo San Antonio (Arg.). Other species: Canelon capororoca, capororoca colorada, kaáporoka, kaá-pororó, pororoka (Arg.); capororoca, jómirim, azeitona do matto (Braz.); myrsine (Bah.); cucharo (Col.).

General properties: Color dull ashy-gray, sometimes with a rosy hue, and inclined to be striped. Sapwood lighter; not sharply defined. Highly figured on radial surface.

Odor and taste absent or not distinctive.

Rather light and soft. Sp. gr. (air-dry) 0.55. Weight about 34 lbs. per cu. ft. Grain fairly straight. Texture coarse. Wood easy to work, but does not turn smoothly; is rather soft, but tenacious; does not appear durable.

Growth rings: Absent or very poorly defined.

Parenchyma: Sparingly developed about pores; not distinct with lens.

Pores: Very small; rarely visible without lens; fairly numerous, but not crowded; occurring mostly in radial rows of few to several pores each; groups well distributed.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Large and conspicuous on all sections; appear to make up about one-third the area on tangential surface; give a very pronounced silver grain on radial surface, where they appear considerably darker than background, resembling sycamore (*Platanus*). Aggregates of resinous cells, sometimes

yellowish, sometimes very dark brown, readily visible; the dark-colored ones giving a distinct speckled appearance to rays on radial section.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The cape beech of South Africa (Yale Nos. 866, 4488) has much the same structure, but the rays are not as coarse, the texture is finer, and the wood is heavier and more compact. The woods differ from the Dilleniaceae in that the pores are much smaller, are arranged in radial rows instead of occurring singly, while the vessel perforations are simple, the wood fibers have simple pits, and the rays contain resinous patches. In the Proteaceae, also characterized by broad rays, the pores and parenchyma are in distinct tangential arrangement.

Material: Yale Nos. 994, 1027, 3995, 6250 (Arg.); 3144 (Braz.).

66. SAPOTACEAE

The Sapodilla Family consists of about 50 genera and over 500 species of trees and shrubs of wide distribution throughout the tropical and warm regions of the world. They are characterized by a milky juice which in some instances is the source of gutta-percha, balata, and chicle, products of very much greater commercial importance than the woods. The leaves are usually tufted at the ends of the branches, and the small whitish or green flowers are in little clusters in the axils of the lower leaves or on the old leaf scars. The fruits, which often are very large, are succulent and edible, and many of the trees are cultivated on this account. The seeds of some species are sources of food and oil.

The wood is typically hard, heavy, and strong and of two principal colors, reddish and yellowish. The pores are in more or less definite radial arrangement, the parenchyma is in numerous fine tangential or concentric lines, and the rays are always narrow. The vessels have either simple or scalariform perforations or both; the rays are heterogeneous with large elliptical or much elongated simple to half-bordered pits where in contact with the vessels; the fibers have thick walls, small cavities, and simple pits. The red woods, of which *Mimusops* is the type, are among the most important of the tropical timbers, their durability, hardness, and strength adapting them to a wide range of uses.

LABOURDONNAISIA

There are about eight known species of this genus, mostly natives of Mauritius and neighboring islands. The only tropical American species is the "acana" or "almiquí," *Labourdonnaisia albescens* Benth., of Cuba, where it attains medium size, has a very hard, deeply furrowed, gray to dark bark, and a crown composed of rigid twisted limbs and comparatively few small branches. The fruit resembles that of the

"níspero," *Achras Zapota* L., and is eaten by the children in the country, though it is very unpalatable and filled with a sticky juice like that of an unripe "níspero." The wood is usually very wavy-grained, of a deep rich red color, has an oily appearance and feel, and is so hard that it is difficult to nail without splitting and railway ties of it have to be bored before spiking. It takes a beautiful polish and is often used for making fine walking sticks and is suitable also for interior trim, turnery, umbrella handles, and cabinetwork. It is fairly well known in the New York market under the names almique, acana, and donsella. This last name, according to the best information available, was given to this wood by an importer some years ago and is not to be confused with the "sangre de doncella" which is a species of *Byrsonima* (Malpighiaceae).

THE WOOD

Labourdonnaisia albescens Benth. *Almique.*

Common names: Almique, acana, donsella (Trade); acana, almiquí (Cuba).

General properties: Color red or reddish-brown, often with a mingling of lighter and darker shades; deepens upon exposure; has an oily appearance and feel. Sapwood thin, white.

Without characteristic odor; taste somewhat astringent and bitter.

Very hard, heavy, and compact. Sp. gr. (air-dry) 0.97. Weight about 60 lbs. per cu. ft. Grain mostly wavy or roey. Texture fine, uniform. Wood fairly easy to work, takes a high waxy polish, holds its shape, is highly durable.

Growth rings: Often fairly distinct, though not sharply defined; due to darker-colored zones deficient in parenchyma.

Parenchyma: In very numerous, irregular, wavy, poorly defined concentric lines or bands of irregular width; usually not individually distinct without lens.

Pores: Small; not individually visible without lens and not very distinct with it, as they are filled with tyloses and tend to blend into the background; not very numerous; arranged in scattered radial rows of several pores each, sometimes distinct without lens.

Vessel lines: Fine and indistinct.

Vessel contents: Tyloses abundant; sometimes gummy.

Rays: Very fine; not visible without lens on cross section; invisible on tangential; fine and inconspicuous on radial surface, being of same color as background.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: The most characteristic feature of this wood, in contrast with the others of the family, is its oiliness. In this respect it resembles certain of the Anacardiaceae from which it is readily distinguished by its concentric parenchyma lines, radial lines of pores, and the absence of gum ducts.

Material: Yale No. 4985, 4996, 5014 (Cuba).

ACHRAS

The "níspero," *Achras Zapota* L.,[210] is a small to medium-sized tree indigenous in southern Mexico, parts of Central America, and possibly in Colombia and Venezuela; it is now cultivated throughout the tropics. The glossy, leathery, evergreen leaves are clustered at the ends of the branchlets, as are also the small white flowers. The fruit is a berry of variable form and size, superficially resembling an immature walnut, with few to several rather small seeds; the skin is thin, the meat reddish, somewhat milky, melting, and sweet; it is ranked by many among the best of the tropical American fruits.

The condensed latex of this tree, or one closely related to it,[211] is the commercial chicle from which chewing gum is made. The trees are tapped during the rainy season by making V-shaped gashes in the bark and collecting the milky sap in small receptacles. The water is driven off by heating in shallow kettles and kneading with a stick, after which the chicle is made into little loaves for export. It is said that a tree in its prime will produce more than 20 pounds of gum in a season, but after numerous tappings the yield will drop to only a pound or two, though a few years' rest will often restore in large measure the sap-producing ability. The principal source of supply is southern Mexico, about five million pounds being produced annually.

The wood is used in the manufacture of native carts and to a limited extent for other purposes. It is hard and heavy, specific gravity (air-dry) 1.09, fine-textured, durable, the heartwood of a dark reddish color, suggesting bullet wood (*Mimusops*); the distinct sapwood pale reddish. The pores are small, barely visible, arranged in short and rather irregular radial rows of few to several pores each. Parenchyma is in numerous, fine, closely spaced, concentric lines, faintly visible without the lens. The rays are very fine, not visible on cross and tangential sections, visible, but inconspicuous, on the radial. *Material:* Yale Nos. 2144* (Curaçao); 3734*, 3745 (Guat.-Hond.); 4322 (Pan.); 4771 (Mex.); 4570 (P. R.). Asterisk indicates botanical material.

Common names: Sapodilla, naseberry, neesberry, nisberry (B. W. I.); níspero (Span. Am., gen.); zapote, sapote (Cuba); sapotier, sapotille, sapotiller, sapotillier (Fr. W. I.); mispel, mispelboom (D. W. I.); chico, zapote chico, chicozapote (Mex., Guat.); tzicozapotl, ya (Mex.); níspero quitense (Ec.); muyozapot (Salv.); korób (C. R.); ibán (Nic.); muy, sapodilla, chicle

[210] Synonyms: *Achras Sapota* L., *Sapota Achras* Mill., *Sapota Zapotilla* Coville.

[211] According to Pittier (*Journ. Wash. Acad. Sci.*, 9: 431-438, 1919), the source of most of the chicle used in the manufacture of chewing gum is *Achras Chicle* Pittier. Some investigators claim that the chicle of Venezuela is from a species of *Mimusops*. That of Colombia is said to be from *Couma* sp. (Apocynaceae).

(Guat.); sapotilla (Braz.); breiapfel, sapotillbaum (Germ.); chicle tree, chewing-gum tree (Misc.).

CALOCARPUM

The "sapote," *Calocarpum mammosum* (L.) Pierre,[212] is a large deciduous tree sometimes 100 feet high with an erect, but usually short, trunk covered with reddish-brown, shaggy bark with a milky juice. It is one of the principal fruit trees of the West Indies, northern South America, and Central America and belongs to the class of semi-cultivated plants. Pittier[213] says: "The fruit has a thick mesocarp of a reddish or pinkish color, and a little sticky on account of the latex it contains. The flavor is sweetish, with a peculiar squashy strain, quite delectable if we believe some Spanish authors, but not generally to the taste of foreigners. This strain might, however, be removed or improved by appropriate selection and culture. That same mesocarp can also be turned into an excellent marmalade, or into jelly, and although the fruit does not yet seem to have met with any great favor in our markets, it is not altogether without importance among tropical fruits. The seed contains a large, oily almond, which has a strong smell and a bitter taste. . . . In Costa Rica . . . the whole almond, finely ground, is made into an excellent confection. Moreover, . . . it seems to have been extensively used, and is still used on a small scale, in conjunction with cacao, in the preparation of the current beverage of the natives of Central America. It is called 'sapuyul.' . . . As a historical memorandum, we may also mention that during the first half of the nineteenth century the same seed was still used in Costa Rica in lieu of the present iron to smooth starched white linen."

The wood is used to some extent for construction purposes and is suitable for furniture and many other purposes, but the supply is limited and uncertain since the tree is usually protected by the natives on account of the fruit. Moreover, the trees are often too short-boled to produce good log lengths. The wood, which is of a light reddish color with a whitish sapwood, is hard and heavy, medium-textured, not very difficult to work. Growth rings are fairly distinct, due to narrow zones without parenchyma, the latter being in exceedingly numerous fine lines, producing a network with the rays, not individually distinct without lens. The pores are visible and arranged in radial or diagonal rows which are not very numerous. The rays are fine, faintly visible on cross

212 Synonyms: *Acras mammosa* L., *Sideroxylum Sapota* Jacq., *Lucuma mammosa* Gaertn. f., *Lucuma Bondplandia* H. B. K., *Vitellaria mammosa* Radlk., *Calospermum mammosum* Pierre, *Acradelpha mammosa* Cook.

213 Pittier, Henry: New or noteworthy plants from Colombia and Central America, 4, *Cont. U. S. Nat. Herb.*, 18:2:83 (1914).

section, invisible on tangential, very distinct on radial, where they produce a fine silver grain. *Material:* Yale No. 3680, with leaves and fruit (Guat.-Hond.).

Common names: Sapote, mamee-sapote, marmalade fruit, marmalade tree (B. W. I.); mamey, mamey colorado, mamey zapote (Cuba); sapote, zapotte, gross zapotte, zapotte à crême, sapotille mamey, marmalade naturelle (Fr. W. I.); bartaballi, balataballi (B. G.); zapote mamey (Col.); mamey colorado (Col., Venez., Ec.); zapote (C. A., Mex.); zapote colorado, zapote mamey, mamey colorado, tezonzapote, tzapotl, tsapas sabani, haaz, chacal haaz (Mex.); sal-tul, tul-ul, chul, chul-ul (Guat.); ingerto, zapote ingerto (Salv.); beko, kurók, kóm-kra, fiú (C. R.); oa-bo (Pan.); sapote-assú, palata, uique (Braz.).

SIDEROXYLON (SIDEROXYLUM)

This genus consists of about 100 species of trees and shrubs widely distributed in the tropical regions of the world, with a few species in Australia, Madeira, South Africa, New Zealand, and Norfolk Island, and one species reaching the shores of southern Florida. Some of these are large and valuable timber trees, with hard and heavy woods of a light yellow to orange color.

The "gumbijava" of Brazil, *Sideroxylon Gardnerianum* A. DC., is a medium-sized to large tree which in Serra do Mar attains a height of more than 100 feet and a diameter exceeding three feet. The yellow or orange wood is fairly easy to work, splits readily, and, while not durable enough for exposed structures, is esteemed for joinery and for furniture, especially chairs.

The best known of the Central American species is the "tempisque" or "tempixque," *S. Tempisque* Pittier, a medium-sized to large tree of Guatemala and Salvador. The hard wood is of good quality, but is little used because the natives protect the trees on account of their fruit, which, however, is more or less sticky and not very highly esteemed. Another form of this tree, the "tempixquillo," has a smaller, sweeter, and less sticky fruit. The "capiri," *S. Capiri* Pittier, is a medium-sized tree of the west-central part of Mexico. In British Guiana there is an unknown species of *Sideroxylon* (Kew identification), known locally as "vogel kop," or "kudibutshi," a tree with a white latex and a pale yellow, hard wood.

The mastic, *Sideroxylon Mastichodendron* Jacq., is a valuable tree of the West Indies and southern Florida. Though rarely over 50 feet high, it usually has a stout trunk, often two to three feet in diameter. Mr. H. S. Graves measured a tree in eastern Cuba that was 50 inches in

diameter five feet above the ground. The trunk often shows a tendency to become twisted and somewhat fluted, with considerable flare at the base. The wood is used for general construction, carpentry, cabinet-work, shipbuilding, vehicles, ox-yokes, fence posts, and railway ties.

THE WOOD

Sideroxylon Mastichodendron Jacq. *Mastic.*

Common names: Mastic, wild olive (Fla., B. W. I.); jocuma, jocuma amarilla, jocuma prieta, caguaní, ebano amarillo, lechero (Cuba); ausubo, tortugo, tortugo amarillo, tortugo prieto (P. R.); mastic bully (Bah.); acoma batard (Guad.); acouma jaune, abricot des bois (Fr. W. I.); acoma, mastic (Trin.). Other species: Bull-apple (B. W. I.); cocuyo (Cuba); tabloncillo (P. R.); fogel kop, vogel kop, kudibutshi, kokeriti-balli (B. G.); bois de fer (Fr. G.); chupón colorado (Venez.); guaraja, gumbijava, gumbixava, gumbixama (Braz.); tempisque, tempixque, saquaia, kobak (C. A.); capiri, tempísco (Mex.).

General properties: Color yellow or orange. Sapwood yellow; not sharply defined.

Without distinctive odor; taste bitter.

Very hard and heavy. Sp. gr. (oven-dry) 1.01 (Tenth Census). Weight about 63 lbs. per cu. ft. Grain fairly straight to roey and wavy. Texture medium. Wood tough and strong, not easy to work, takes a smooth and lustrous finish, likely to check in drying.

Growth rings: Usually distinct, due to narrow zones deficient in parenchyma.

Parenchyma: In exceedingly numerous, mostly very closely spaced, wavy and irregular tangential or concentric lines, producing a fine network with the rays; not individually distinct without lens, but giving the section a whitish appearance, with zones of deeper color at irregular intervals.

Pores: Small; mostly in radial groups of two or three, the groups usually in radial rows; not very numerous; closed.

Vessel lines: Not conspicuous.

Vessel contents: Tyloses abundant.

Rays: Invisible without lens on cross and tangential sections; inconspicuous on radial surface, being of same color as the background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations. Rays heterogeneous; commonly biseriate in middle portion; crystals common; pits into vessels large, elliptical or much elongated vertically or laterally. Fibers with exceedingly thick walls and minute cavities; pits simple.

Remarks: The wood of *S. Tempisque* Pittier (Yale No. 3730*, Guat.-Hond.) is lemon-colored; growth rings are apparently absent; the parenchyma lines are uniformly distributed and appear to extend only from ray to

ray; the pores are in radial groups of two or three, but the groups are mostly isolated; the rays are faintly visible on cross section.

Material: Yale Nos. 5180*, 5182* (Florida); 774, 5006 (Cuba). Asterisk indicates botanical material.

BUMELIA

This genus consists of about 35 species of shrubs and small trees distributed from the southern United States through the West Indies to Mexico, Central America, and Brazil. There are 12 species in the United States, five of which are small trees.

One of the largest trees is the "ibirá-nirá" of northern Argentina, *Bumelia obtusifolia* R. & Sch. It attains a height of 55 to 65 feet, with an erect trunk sometimes over three feet in diameter; according to Castro,[214] occasional specimens are found in Tucumán that are 130 feet high and 6½ feet in diameter. The timber is used in vehicle construction, furniture, tool handles, and general carpentry. It makes a good fuel even when green.

THE WOOD

Bumelia obtusifolia R. & Sch. *Ibirá-nirá.*

Common names: Ibirá-nirá, ibirá-hú, horco molle, cabo de lanza, lanza colorada, molle crespo, molle del monte, molle negro (Arg.); chupón (Venez.). Other species: Ironwood, buckthorn, ants' wood, downward plum, saffron plum, chittam wood (U. S.); cucuyo, jiqui espinoso, sapote espinoso, cucuyo de sabana (Cuba); bois blanc, como (Haiti); bois de fer blanc, bois de bouis, petit bouis (Fr. W. I.); boxwood, breakbill (Windward I.); pajui, igüi, malarmo (Venez.); pali leche (Curaçao); caimitillo (Pan.); espino (Col.); coma (Mex.); rompe gibão (Brazil).

General properties: Color yellow or yellowish-brown, sometimes with greenish veins. Sapwood nearly white; not very distinct.

Odor and taste absent or not distinctive.

Very hard and heavy. Grain fairly straight. Texture rather fine. Wood brittle, not easy to work, takes a smooth and somewhat satiny finish; does not appear durable.

Growth rings: Poorly defined; sometimes indicated by narrow zones deficient in parenchyma.

Parenchyma: In very numerous, closely spaced, wavy concentric lines; visible without lens; also in association with pores.

Pores: Small; not individually distinct; arranged in wavy or branching radial rows or patches that are readily visible, being considerably lighter than background.

Vessel lines: Mostly fine and inconspicuous; some dark green and conspicuous.

[214] Castro, Eduardo B.: *Les madeiras Argentinas*, Rosario, 1917, p. 66.

Vessel contents: Green gummy substance sometimes present in irregular patches.

Rays: Indistinct without lens on cross section; invisible on tangential; fine and inconspicuous on radial surface, being of same color as background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations. Rays mostly biseriate; widely variable in height; mostly heterogeneous; pits into vessels large, elliptical, or much elongated, simple to half-bordered. Wood fibers very thick-walled with minute cavities and simple pits. Parenchyma abundant in rows or bands and among pore groups.

Material: Yale Nos. 1044*, 3974, 6253 (Arg.). OTHER SPECIES: Yale Nos. 2137* (Curaçao); 4073 (Venez.); 5181* (Fla.). Asterisk indicates botanical material.

LUCUMA

This genus contains a great many species of general occurrence in tropical America, but centering in Brazil and Peru. The bark is rich in tannin and also yields a latex from which a kind of gutta-percha is obtained. The fleshy, olive-like fruits are edible, though an exception occurs in the case of *Lucuma schlerocarpa* Pittier of Panama, the fruit of which has a woody pericarp.

Huber[215] says that the "cutitiribá," *L. rivicoa* Vahl, is a common tree of the uplands and high flood plains of Pará, supplying a wood that is softer and more porous than that of *Mimusops*. The "abieiro" or "abiu," *L. Caimito* R. & P., one of the most highly esteemed fruit trees of the Amazon region, has a very compact, heavy, and strong wood of a beautiful dark color, without sharp distinction between heart and sap. There are several species of *Lucuma* in the swamps of the upper Amazon, where they are known under the general name of "abiurana," but the timber is little used. The name "guajará" is applied to some of the trees of this genus, as well as to certain others of the family.

The only authentic wood specimens in the Yale collections are of the "mucuri," *L. procera* Mart., of Bahia, Brazil. The tree is plentiful along the mountain streams of that region and attains a height of 90 feet and a diameter of two feet or more. The wood is much like that of "massaranduba" (*Mimusops*) and is used for all sorts of heavy and durable construction and in carpentry.

THE WOOD

Lucuma procera Mart. *Mucuri.*

Common names: Mucuri, chauá, massaranduba branca (Braz.). OTHER SPECIES: Abieiro, abiu, abiurana, abiarana, cutitiribá, otiturubá, goititurubá,

215 HUBER, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:200 (1909).

guajará, guapéba, bapéba, bapéba assú, grão de gallo, lucuma, macaca, macaca vermelha, imyracem (Braz.); lucmo, lucumo, locma (Peru); jaune d'oeuf, prunier jaune d'oeuf, balata jaune d'oeuf, pomme de pin (Fr. G.); pourouma (Galibis); assapoko, barata, male bullet tree, kokeriti-balli, sororo-borieng (B. G.); canistel, sapote culebra, siguapa (Cuba); egg-fruit (Bah.); acána, hacána, jacána (P. R.); contrevent (B. W. I.); mamón (C. R.); ingerto de montaña, silion ? (Guat.); güicume (Salv.); zapote borracho (Mex.).

General properties: Color dull reddish-brown, continuing almost to the bark.

Without distinctive odor; taste astringent.

Hard and heavy. Sp. gr. (air-dry) 0.90. Weight about 56 lbs. per cu. ft. Grain straight. Texture rather fine; wood not very difficult to work, splits readily along the rays, finishes smoothly, is very strong and tough; appears highly durable.

Growth rings: Poorly defined; sometimes present, due to narrow zones deficient in parenchyma.

Parenchyma: In very numerous fine wavy concentric lines, fairly distinct without lens; visible on tangential surface in proper light.

Pores: Small, but visible; in radial groups of two to four; with tendency to arrangement of groups into diagonal rows; not very numerous.

Vessel lines: Very fine; distinct only in proper light, when they appear lighter than background.

Vessel contents: None observed.

Rays: Very fine and numerous; not visible without lens on cross and tangential sections; very distinct on radial surface, appearing of deeper red color than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations, though occasional scalariform perforations with few bars have been noted in other species. Rays heterogeneous, many of the cells square or upright, filled with gum; uniseriate or biseriate in part and many cells high; pits into vessel large, much elongated, axially or vertically, resembling a scalariform perforation, simple with transitions to half-bordered. Fibers thick-walled with indistinct simple pits.

Remarks: Some of the other specimens believed to be of this genus have a similar structure, but are mostly lighter in color, usually with a yellowish tinge. There are also variations in the distinctness and regularity of the parenchyma lines.

Material: Yale Nos. 1778 and 4695, with herbarium material, collected by Mr. Curran in Bahia. Other species: Yale Nos. 1936, 3186, 3480, 3637, 4261 (Braz.).

CHRYSOPHYLLUM

This genus, with over 60 species of evergreen trees, is most abundant in tropical America, a few species occurring in western and southern

Africa, southern Asia, Hawaii, and Australia. One species, *Chrysophyllum oliviforme* Lam., the satin-leaf, reaches the shores of southern Florida. The specific gravity (oven-dry) of its wood is 0.94 (Tenth Census).

The most valuable species, *C. Cainito* L., is a native of the West Indies, now cultivated in all tropical countries and naturalized in many parts of Central and South America. It produces the so-called star-apple, a succulent edible fruit of the size and shape of a small apple. The leathery leaves are a bright blue-green on the upper surface and covered with a copper-colored satiny pubescence beneath.

The woods of this genus vary in color from pinkish-brown to reddish-brown, are hard and heavy or moderately so, and have a structure much the same as that of *Lucuma*. They are used for general construction and carpentry, and the darker-colored kinds are suitable for exposed structures.

Common names: Satin-leaf (Fla.); satin-leaf, star-apple, saffron tree (B. W. I.); caimito, cainito (Span., gen.); caimito blanco, caimitillo (Cuba); caimito morado, caimito verde, caimito de perro, lechesillo (P. R.); caimitier, cainitier, bouis, contrevent, pomme sûrette (Fr. W. I.); cayumito (Yucatan); cainito, guajará, uacá (Braz.); aguaý, aguaý amarillo, aguaý-sayýu, blanquillo colorado, carne de vaca, carapun, lanza blanca, olivo-rá, picazu-rembiu, vasurinha (Arg.).

PRADOSIA

The single species, *Pradosia latescens* (Vell.) Radlk.,[216] is a large forest tree of São Paulo and regions farther north in Brazil. In Bahia it reaches a height of 100 to 125 feet, with a long straight trunk three or four feet in diameter, without buttresses. The bark is smooth, and the reddish inner part contains only a small amount of latex and is very sweet to the taste, though astringent. The latter property is due to the high tannin content (upward of 30 per cent), which gives the bark value for tanning purposes. The extract, "monesia," has various medicinal applications.

The wood, which resembles rock elm (*Ulmus racemosa* Thom.) in general appearance and properties, has a sweet taste and is heavy, tough, and strong. It is considered an excellent material for the manufacture of vehicles, implements, and oars, and for use in heavy construction not exposed to decay. It appears well suited for tool handles, spokes and felloes of wheels, cooperage, and bent work. It does not dry readily and the thick sapwood is likely to become stained.

216 Synonyms: *Chrysophyllum glycyphloeum* Casar., *C. Buranhem* Riedel, *Lucuma glycyphloea* Mart. & Eichl., *Pradosia glycyphloea* Liais.

THE WOOD

Pradosia latescens (Vell.) Radlk. *Buranhem.*

Common names: Buranhem, buraem, burahem, buranhen, buranhé, guaranhen, guaranhé, guranhem, gurenhem, guranham, guranhen, casca doce, páo doce, imyracem (Braz.); sweetbark tree, sweetwood (Eng.).

General properties: Color dull grayish; somewhat variegated or streaked with yellow and brown or purplish-brown, but not pronounced. Sapwood thick, light gray to nearly white; not sharply defined; likely to be stained.

Without distinct odor. Taste sweet; highly characteristic.

Hard and heavy. Sp. gr. (air-dry) 0.94. Weight about 59 lbs. per cu. ft. Grain fairly straight. Texture medium. Wood very tough and strong, fairly easy to work, finishes smoothly, but with little luster; does not appear durable.

Growth rings: Fairly distinct, due to narrow zones deficient in parenchyma; usually visible on tangential surface.

Parenchyma: In very numerous, closely spaced, fairly regular to very irregular tangential to concentric lines or bands, white in color, and generally considerably wider than the rays; the finely laminated structure usually visible on radial surface.

Pores: Very small; not visible without lens; rather few; mostly in scattered groups of two, the groups only occasionally forming radial lines; open.

Vessel lines: Very fine and indistinct.

Vessel contents: None observed.

Rays: Very fine; not visible without lens on cross and tangential sections; fairly distinct on radial surface, being slightly darker than background; upright cells rather coarse, visible with good hand lens.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits minute, exceedingly numerous. Rays heterogeneous; one to three cells wide and often over 100 cells high; pits into vessels mostly simple, very irregular, often resembling small vessel perforations. Fibers thick-walled, with inconspicuous simple pits.

Remarks: This wood is distinguished from all other known woods of this family by its sweet taste, its peculiar color, and the exceedingly small bordered pits of the vessels.

Material: Yale Nos. 610, 4694 (Braz.); the latter with botanical material collected by Mr. Curran in Bahia.

MIMUSOPS

This genus, the most important of the family, consists of upward of 150 species of evergreen trees or rarely shrubs of general distribution in the tropics. It is noted for its very hard, strong, and durable red wood and for its latex, which is the source of balata, a highly valuable article

of commerce. Many of the species are among the largest of tropical trees.

Although there are various species which yield the true balata, the best known is *Mimusops globosa* Gaertn. of the Guianas and northern South America; the Panama species is *M. darienensis* Pittier. The mature trees are commonly over 100 feet high and sometimes 150 feet, with smooth, straight, cylindrical trunks free of branches for nearly half the total height of the tree, and from five to seven feet in diameter. They make the best development in the river bottoms, but their growth is not rapid and it is estimated that the largest trees are from 400 to 600 years old. In British Guiana the collecting of balata is the foremost forest industry and in value of the exports is the third most important of the country; over a million pounds are exported annually, mostly to England. The United States imports an equal amount, principally from Surinam and Venezuela, though some is obtained from British Guiana, Jamaica, and Panama.

The tapping operations, as practiced in British Guiana, are described by Anderson[217] as follows:

> The bleeder starts by cutting two oblique channels, extending halfway round on the trunk near the base of the tree, below which a niche is cut in the bark, in which a calabash is inserted by the brim so as to catch the latex. A series of similar oblique channels are then cut at about 10 inches apart in criss-cross or feather-stitch pattern, each upper channel entering the lower one in alternate succession so as to continue one above the other in two vertical parallel alignments a short distance apart up the trunk of the tree.
>
> The milk so collected is then poured into gourds (goobees) or kerosene tins, and transported in these to the main camp, where it is placed in specially prepared shallow trays called dabrees, in which it is exposed to the sun and air to dry. Each dabree is provided with an adjustable weather screen constructed of palm leaves, by which the tray can be protected in case of rain. As soon as the upper layer has become sufficiently thick and firm to allow of removal, it is taken off, hung up first inside out to drip, and the sheet so obtained is then removed to a shelter to complete the drying. This process is continued until the tray is empty, but fresh supplies of milk are often added to the dabree tray after the removal of the dried layers. When dried in the dark, balata is pure white, but on exposure to light it turns pinkish, and eventually becomes deep dull-red.
>
> Block balata is prepared by the more rapid process of boiling the latex, and then running it into moulds to dry, and when treated in this way it assumes a dark or blackish colour. But in this form it is in disrepute, as many odds and ends have been found imbedded in the thick blocks, purposely added to increase their weight and so defraud the purchaser.

217 Anderson, C. W.: *Report on the easily accessible forests of British Guiana,* Demerara, 1912, pp. 35-37.

Unfortunately there is no reliable data available as to the yields obtained on the successive tappings made after the tree has first been bled, the class of men employed as bleeders and the condition under which the work is carried on being such as to render it difficult if not impracticable to obtain such data. Yet the indisputable fact remains that tracts of Crown Lands on which the balata trees were first tapped a quarter of a century ago are still being worked and continue to yield supplies of balata.

The wood of the balata tree is of a brownish-red color, darkening upon exposure, and because of its color is sometimes called beefwood and horseflesh, though it is more commonly known as bullet wood or bully, probably corruptions of balata, and is sometimes offered in the retail markets of New York City under the name of South American mahogany. The wood has a specific gravity of about 1.00, though sometimes it is considerably heavier, and is fine-textured, straight-grained, not especially difficult to work considering its density, and is highly resistant to decay and insect attacks, but not to the teredo; large timbers are subject to heart shake. The uses include all kinds of heavy and durable construction, railway ties, bridges, posts, and poles; and, to a limited extent, furniture, and fishing-rods.

Mr. Curran supplies the following note regarding the balata of Venezuela: "This tree occurs along with *Carapa* in the overflow lands of Orinoco delta, where it reaches a height of 100 feet with diameters of two to three feet. I have never seen the wood on the Venezuelan markets, the principal use of the tree being the production of balata gum. Many Venezuelans have camps through the delta, each with from 50 to 100 natives and Indians engaged usually in the dual occupation of gathering gum and harvesting mangrove bark. It is the custom to collect the latex from felled timber, though attempts are being made to introduce the more economical method of tapping the standing trees as is done in the Guianas. The white latex is brought into camp in 5-gallon oil tins, allowed to stand awhile, and then poured into open vessels over wood fires and constantly stirred. The product is then poured into molds and stored under water until taken to market."

According to Huber,[218] the best known woods of the Sapotaceae in the Amazon region are furnished by several species of *Mimusops*, which are commonly large trees. The "massaranduba" of Pará corresponds to two species, namely, *Mimusops amazonica* Huber, and *Mimusops* aff. *elata* Fr. Allem., which seem to be well distributed throughout the state. They are tall trees of the higher uplands, and their longitudinally fissured gray bark contains a latex which furnishes a balata of inferior quality. The wood, which is very dense, homogeneous, and of a dark

[218] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6: 198-200 (1909).

reddish color, is excellent for railway cross-ties and is used also for civil construction, though too heavy for many purposes for which it is otherwise well adapted, and for tool handles, spokes of wheels, walking sticks, etc. Huber considers it probable that the true balata, *Mimusops bidentata* DC., also occurs in the State of Pará. The woods of the "maparajubas," *M. paraënsis* Huber and *M. Parajuba* Huber, though resembling "massaranduba," are not as good for general construction, but are more highly valued for fuel because the wood burns well even in a green condition.

Mr. Curran says: " 'Massaranduba' is a well known Brazilian timber much used for railway ties and heavy durable outside construction. The trees occur scattered through the hardwood forests of the coast, but are nowhere abundant, and the available supply near transportation has been nearly exhausted. They are of large size, 100 feet high and three or four feet in diameter, with a dark brown or blackish bark of medium thickness, and heavy, dark green leaves six to eight inches long. The heartwood is extremely hard and of a deep red color; the sapwood is usually narrow and almost white when freshly cut."

The woods of the various tropical American species of *Mimusops* are much alike in their structure and properties, with minor variations in color, density, and texture that are probably as great within a species as between different species.

One of the trees of special interest in northern South America is a species of *Mimusops* with a latex that is not sticky when fresh and which can be used in limited amounts as a substitute for cow's milk. Spruce[219] says of this tree:

> One of the objects which most took my attention at Pará was the "maçeranduba," "milk-tree" or "cow-tree," so called from its bark secreting abundance of drinkable milk. I saw several trees of it at Tanaú, and made trial of the milk, fresh from the tree, both alone and mingled with coffee. The milk flows slowly from the wounded bark; its consistency is that of good cream, and its taste perfectly creamy and agreeable. It retains its fluidity for weeks, but acquires an unpleasant odour. It is extremely viscid, and can with difficulty be removed from the hands or whatever else it touches—a property which renders it an excellent substitute for glue, but a rather unsafe article of diet, and serious cases of constipation have resulted from its being partaken of too freely. When dried it quite resembles gutta-percha, and I have no doubt might be put to the same uses.

Almost every region of tropical South America has its cow-tree. That of the coast of Venezuela rendered famous by the researches of Humboldt and Bonpland, and of Blussingault, is an Artocarp, of the genus *Brosimum;* but

219 Spruce, Richard: *Notes of a botanist on the Amazon and Andes,* London, 1908, Vol. I, pp. 50-52.

this of Pará is a Sapotad, with large leaves, white beneath, close parallel veins, and edible berries, as most others of the tribe have. I afterwards fell in with two species bearing the same native name, and having quite the same habit, on the Casiquiari and Upper Rio Negro. Their milk, however, was scarcely drinkable, although it possessed the other properties of that of Pará, and was in universal use as glue. A hammock which I purchased there for the Museum of the Royal Gardens at Kew has the borders ornamented with beautiful devices in bird's feathers, all stuck on with the milk of the "maçeranduba." I gathered flowers and fruit of both species, which proved them to be species of *Mimusops,* and therefore congeners of the "bully-tree" of Tobago, and probably also of the "balata" of Demerara.

All the species known to me have a deep, dull red, heavy, close-grained wood, much esteemed for its durability. I have seen a perfectly straight squared log of it, 60 feet long, brought from the Casiquiari, and fashioned at San Carlos into the keel of a schooner. The Brazilian frigate Imperatriz built at Pará in 1823, chiefly of "maçeranduba," was in 1849 still perfectly sound and seaworthy.

THE WOOD

Mimusops spp. *Bullet Wood; Massaranduba.*

Common names: Bullet wood, bully tree, balata tree, beefwood, horseflesh, red lancewood, baruch, buruea (B. G.); bolletrie, bolletrieboom, balataboom, bloedbalata, pardeflesh, pardenvleesh, roode balata (Sur.); balata, balata franc, balata rouge, bois rouge, bois de natte, sapotillier marron, manil-kara, l'abeille, hymarikushi, mora-balli, assapookoo, morakokuru, mamushi (Fr. G.); acana, ausubo, balata, mameyuelo, sapote, sapote de costa, zipote (P. R.); jaimiqui (Cuba); wild dilly (U. S., Bah.); balata, purgo (Venez.); nispero (C. A.); massaranduba, massaranduba amarella, massaranduba de leite, massaranduba vermelha, maçeranduba, maparajuba, aparahiú, apraiú, apraua, balata, chauá, muirapiranga (Braz.); pferdefleischholz (Germ.).

General properties: Color light red to deep reddish-brown, deepening upon exposure; usually dull. Sapwood lighter; not always sharply defined.

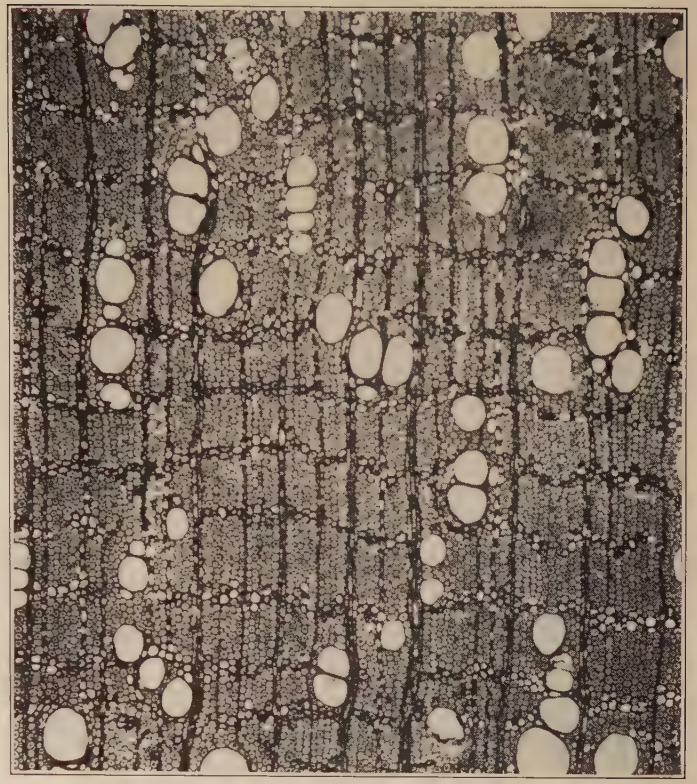
Odor and taste absent or not distinctive.

Dense and hard to extremely so. Sp. gr. (air-dry) 0.90 to 1.25. Weight 56 to 78 lbs. per cu. ft. Grain mostly straight; sometimes wavy. Texture rather fine; somewhat harsh. Very strong, not easy to work, takes high polish, likely to check in drying; is highly durable.

Growth rings: Present or absent; when present due to darker areas of poreless zones.

Parenchyma: In numerous fine closely, but not always evenly, spaced wavy concentric lines (sometimes broken and irregular), usually visible, but not always distinct without lens; rarely distinct on longitudinal surfaces.

Pores: Small to very fine; not always individually distinct without lens; fairly numerous; arranged in distinct radial or oblique lines appearing lighter than deep-colored background.



Cross Section of the Panama Bullet Wood (x 50).
(*Mimusops darienensis.*)

Photo by H. M. Curran.

Large Sancho-araña Tree in Colombia.
(*Bravaisia floribunda.*)

PLATE XLIX

Vessel lines: Distinct, but not conspicuous; appearing as very numerous long fine scratches, usually lighter than background.

Vessel contents: Tyloses present.

Rays: Very fine and numerous; visible with lens on cross section, but not on tangential; distinct, but not conspicuous, on radial, being of about the same color as the background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessel perforations simple. Rays decidedly heterogeneous; one to three cells wide and few to many cells high, with dark-colored contents; pits into vessels large, elliptical or much elongated, simple to half-bordered. Fibers extremely thick-walled with minute cavities and small simple pits. Crystals of calcium oxalate common in parenchyma and rays.

Material: Yale Nos. 3034, 4099, 4173, 4205 (B. G.); 4198 (Sur.); 2673 (Venez.); 4566 (P. R.); 2507, 3246, 3284*, 3912, 3937, 4017, 4451, 4687* (Braz.); 3013 (Pan.). Asterisk indicates botanical material.

67. EBENACEAE

The Ebony Family consists of six or seven genera and a great many species of trees and shrubs, widely distributed in temperate and tropical regions of the world. The most important genus is *Diospyros*, with over 200 species, some of which are cultivated for their fruit, while others yield the true ebony woods of commerce which come from Africa and the Far East; there is no true ebony produced in commercial quantity in tropical America. The common conception of ebony is a wood of charcoal blackness, but there are other kinds that exhibit a wide range of color and are usually variegated. Many of the so-called ebony woods come from entirely different families, especially the Leguminosae.

There are two representatives of *Diospyros* in the United States, namely, the common persimmon, *D. virginiana* L., the wood of which is employed chiefly in the manufacture of weaver's shuttles, and the black persimmon or "chapote" of Texas and Mexico, *D. texana* Scheele, little used except for small tool handles and articles of turnery. The "zapote negro" or "zapote prieto" of Mexico, *Diospyros* sp., grows to fairly large size and yields a very heavy, hard, coal-black wood, not of commercial importance.

The "sapote negro" of Cuba is supposed to be *D. laurifolia* Rich., while the "ebano real" or "ebano carbonero" is *D. tetrasperma* Sw. According to Neville[220] the ebony tree "is found only rarely, and unfortunately its heart is usually so small as to be useless; but when the heart is well developed its beautiful black makes it a favorite among cabinet-

220 Neville, H. O.: Hardwoods in Cuba. *The Cuba Review*, 18: 1: 21, Dec., 1919.

workers and among cane manufacturers. Occasionally a small tree is found in which the line between the heart and sap is very irregular, furnishing material from which canes and other articles can be made, in which a portion of the sap is preserved, thus offering a beautiful contrast between the slightly yellowish white of the latter and the deep pure black of the heart."

The "guayabota," *Diospyros* sp., of Porto Rico is a small tree, rarely over 30 feet high, scattered through the mountains and yielding a small amount of black heartwood. The "guayabota nispero," *Maba* sp., is rarely met with and yields a lighter-colored, though equally hard and heavy wood. *Maba crassinerva* (K. & U.) Urb. is a shrub or small tree up to 25 feet high, occurring in the Bahamas, Cuba, and Santo Domingo. There are species of *Diospyros* and *Maba* in the Guianas, Brazil, and other parts of South America, but they do not supply commercial timber.

The woods of the Ebenaceae are typically hard, heavy, and strong, though the black wood is usually very brittle; parenchyma is in numerous fine closely spaced concentric lines invisible without the lens and sometimes, particularly in black heartwood, not distinct with it; the pores are variable in size, but are usually very small, few, solitary or in radial groups or lines of few to several pores each. The rays are very fine, indistinct to invisible without lens; heterogeneous; the pits into the vessels half-bordered. Ripple marks are characteristic of *Diospyros virginiana* L., the number per inch varying from 55 to 80; they have also been reported in a few species of this genus from Formosa[221] and Japan, but in no instance in the true ebony woods of commerce. The woods of *Maba* and *Diospyros* are not distinguishable. The structure resembles in many ways that of the Sapotaceae and to some extent that of certain representatives of the Anonaceae. *Material:* Yale Nos. 1940 (Braz.); 5244 (Mex.); Misc. specimens from Far East.

68. SYMPLOCACEAE

The Sweetleaf Family consists of a single genus with over 280 species, extensively distributed throughout the tropical and sub-tropical parts of the world, and to a minor extent in the warmer portions of the temperate regions. In general, the members are shrubs and small trees, only a few reaching large size, and are of no commercial importance.

The only species in the United States is the sweetleaf or horse sugar, *Symplocos tinctoria* (L.f.) L'Hér., a small tree common in the under-

[221] See Kanehira, Ryozo: *Anatomical characters and identification of Formosa woods*, Taihoku, 1921, pp. 141-144.

growth of the high forests of the southern states. There are several species in the West Indies, but the only one of general distribution is the "aceituna," *S. martinicensis* Jacq., which furnishes a wood of good quality, but of very limited utility because of the small size and the scarcity of the trees. Some of the Brazilian species are sources of medicines and yellow dyes, the leaves of others are used, under the name "congonha," as a substitute for "mate" (*Ilex*) for making tea, and a few of the trees have useful woods. According to Pereira,[222] the "amarellinho," *Symplocos* sp., has a trunk 30 to 40 feet long and up to three feet in diameter, and the wood, which is of a uniform bright yellow color, fine-textured, and hard to cut, is used for flooring, cabinetwork, turnery, and in naval construction. Another Brazilian species is called "sete sangrias."

S. chiriquensis Pittier occurs in the middle belt of Panama and, at time of flowering, its abundance of sweet-scented blossoms makes it a conspicuous element of the forest. It reaches a height of over 90 feet and has a smooth grayish-barked trunk sometimes two feet through at the base. The wood, which is of a pale yellowish color, is fine-textured, fairly straight-grained, moderately hard, and does not appear durable. It is of about the consistency of birch (*Betula*), and while apparently suited for many useful purposes, is rarely employed except for fuel.

The woods of *Symplocos* as a whole are white, yellowish, or brownish, fine-textured, and variable from light and soft to comparatively heavy and hard. In some species the rays are very fine, in others they are large enough to show distinctly. The pores are always small, but show considerable variation in size, number, and arrangement in different species. Parenchyma is usually poorly developed and scattered, but sometimes is in very numerous, very fine short and irregular lines between the rays and visible only with the lens. The vessels have scalariform perforations with many bars, and scalariform bordered pits are common. The wood fibers have prominent bordered pits and in certain species have fine spirals. The rays are heterogeneous. *Material:* Yale Nos. 3004, collected by Dr. Pittier in Panama, his No. 2994; 2717 (P. R.); 2477 (P. I.); Kanehira's No. 4950 (Formosa).

69. APOCYNACEAE

This large family consists of about 130 genera and considerably more than 1000 species of perennial herbs, shrubs, vines, and trees, which have a very wide distribution, mostly in tropical regions. Most of the plants have a milky juice and in some instances this is a source of

222 Pereira, Huascar: *The timber trees of the State of São Paulo, Brazil,* p. 11.

rubber; many yield products of medicinal value; some are poisonous; a few are ornamental; but only a limited number of them are important for their timber.

There are 37 woody genera in India, a few of which are trees with white, soft, fine-textured woods used locally for carving and turnery. A few plants there are of some economic value as producers of India-rubber. The family is well represented in the Philippines, and Schneider[223] says that by far the best known wood there is "lanéte," *Wrightia*, which on account of its fineness of texture, ease of working, and pure creamy white color, is especially suited for delicate carving.

One of the two South African woods known to the world trade is the so-called Knysna or Kamassi boxwood, locally known as "kamassihout," *Gonioma Kamassi* E. Mey.[224] The yellow wood is used for shuttles and bobbins, but is not suited for engravings, and there is now practically no demand for it by the American trade. The dust arising in working this wood is said to be poisonous to some workmen.

There are at least 15 arborescent genera in tropical America, but with the exception of *Aspidosperma*, a highly important genus, they are practically valueless for their timber. There are various representatives in the Amazon region of Brazil, among which, according to Huber,[225] are the "mangabeira," *Hancornia speciosa* Gomez, a small tree of the savannas known on account of its fruit and the product of its latex; the "amapá," *H. Amapa* Huber, with a latex that is medicinal; the "sorveira" or "sorva," *Couma guianensis* Aubl., of the forests of the coastal region; *C. utilis* Muell. Arg., of the lower Amazon; the "sorva grande" or "cumã-assú," *C. macrocarpa* Barb. Rodr.; the "sucuúbas," *Plumieria* spp.; the "muirajussára" or "bucheira," *Aspidosperma Duckei* Huber. The woods of all of these species are poorly known.

PLUMERIA

The numerous species of this genus are nearly all indigenous to tropical America. A few have been widely planted because of their conspicuous and highly fragrant flowers, which are often woven into garlands, the "lei" of the Hawaiians. The trees are mostly small and are commonly met with in gardens and cemeteries; *P. acutifolia* Poir. of the American tropics is so common about temples in India as to gain the name of temple tree or pagoda tree. The flowers of *P. rubra* L. yield the

[223] Schneider, E. E.: *Commercial woods of the Philippines: Their preparation and uses, Bul.* No. 14, Phil. Bu. For., 1916, p. 202.

[224] The other commercial wood is *Buxus Macowani* Oliv. (Euphorbiaceae).

[225] Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:201 (1909).

perfume known as "frangipanni." *P. alba* L. is a tree from 20 to 30 feet high and from six to 10 inches in diameter, with a hard, compact, very fine-textured wood, of a yellowish-brown color with faint purplish streaks, giving a pleasing appearance. It takes a high polish and is used for articles of turnery. The common names of various species of this genus are: Frangipanni, jessamine, Spanish jasmine, plumieria (B. W. I.); alelí, alelí cimarrón, tabeiba (P. R.); franchipanier, franchipanier rose, balata blanc, bois de lait (Fr. W. I.); frangipanier, lirio morado, lirio de parecloa, lirio blanco, lirio amarillo, lirio de costa, lirio de dulce, lirio de playa (Cuba); azuceno, amancayo (Col.); agoniada, janaúba, sucuúba, sucaúba, corabina (Braz.); juche (C. R.). *Material:* Yale Nos. 803, 2125 (Cuba); 4878 (Haiti); 3389 (Braz.).

TABERNAEMONTANA

This genus includes a large number of species of shrubs and small trees widely distributed throughout the tropics. The "palo vívora" of Argentina, *T. australis* Muell. Arg., is a tree 25 to 30 feet high and from six to 10 inches in diameter. The latex is used medicinally, but the soft white wood, which is about the consistency of tupelo (*Nyssa*), is without value except possibly for paper pulp. *T. arborea* Rose is a tree of Panama 35 to 50 feet high, with a straight trunk 10 to 14 inches through. The wood is yellowish or light reddish-brown, hard and heavy, fine-textured, with numerous pores arranged in short radial lines, and without visible parenchyma. The common names of various American species are: Palo vívora, sapiranguy (Arg.); leiteira, páo de colher, sapiranguy, guacharaco, cojón de cabrito, turma de perro (Braz.); bois de lait, hya-hya, iya, yaruri (Fr. G.); hya-hya (B. G.); jazmín de montana (Cuba); guijarro (C. R.).

ASPIDOSPERMA

This genus, which contains some of the most valuable timber trees in South America, consists of more than 60 known species, chiefly Brazilian. The woods exhibit considerable variation in density, texture, color, and other properties, but are mostly separable into three more or less well-defined groups of which the types are, (1) "quebracho blanco," (2) "peroba rosa," and (3) "piquiá"[226] or "guatambú." There are, however, at least two woods of northern South America which are not readily referable to any of these and are considered under the heading "miscellaneous."

[226] This name is also commonly applied to *Caryocar* spp. (Theaceae).

"QUEBRACHO BLANCO"

"Quebracho blanco," or white quebracho, is the name most commonly applied to *Aspidosperma Quebracho-blanco* Schl. of Argentina, Paraguay, and southwestern Brazil. It is an evergreen tree said to attain a maximum height of 100 feet and a diameter of four feet, though ordinarily it is much smaller. The limbs are stiff; the leaves are harsh and sharp-pointed; the bark is white, suggesting persimmon (*Diospyros virginiana* L.); the flowers are minute and yellow; and the fruit is a rounded fleshy pod two or three inches in diameter, which upon opening liberates a great number of round flat seeds, each with a membranous wing. The tree is abundant in the dry sandy loam of north-central Argentina west of the Paraná River, where the annual precipitation is from 10 to 25 inches. Often it forms the bulk of the stand over hundreds of square miles with 10 to 20 trees of commercial size per acre. The forests are being rapidly destroyed, since the region it occupies is burned over repeatedly by the natives to increase their pasture lands. These fires are often very serious and a single burning sometimes results in the complete destruction of all the timber over many square miles. If this is continued, practically the whole area will be denuded in 15 or 20 years.

Logs reach the market in lengths of six to 10 feet and diameters of 12 to 24 inches, with the bark on. Between one and two million board feet are consumed annually in Buenos Aires and there is always an abundant supply at a comparatively low price. The wood is rather difficult to season and is not durable when exposed in damp situations. A very important use is for hubs and felloes of heavy vehicles. It can be steamed and bent and is consequently in demand for many purposes for which we use ash (*Fraxinus*). It is also used for heavy construction, fuel, and for tannin extract.

THE WOOD

Aspidosperma Quebracho-blanco Schl. *Quebracho blanco.*

Common names: Quebracho blanco, quebracho blanco colorado, quebracho blanco lloron (Arg., Par.); white quebracho (Eng.); weisse quebrachoholz (Germ.); quebraco bianco (Ital.).

General properties: Color yellowish or brownish to rose-red; sometimes more or less variegated; fading upon exposure. Sapwood poorly defined.

Odor and taste absent or not distinctive.

Very hard and heavy. Sp. gr. 0.90 to 1.00. Weight 56 to 62 lbs. per cu. ft. Grain irregular, twisted or roey. Texture medium. Wood hard to cut, takes a high polish, is very strong, tough, resilient; inclined to warp and check in lumber form; not highly durable, though dark-colored portions are fairly so.

Growth rings: Present, but not always sharply defined; due to differences in density and sometimes to fine concentric lines of parenchyma.

Parenchyma: Diffuse and also in very fine irregular, mostly very short, tangential lines barely visible with lens; also in fine concentric lines apparently limiting growth rings.

Pores: Of variable size, the larger readily visible; rather numerous; irregularly distributed, sometimes more or less zonate; mostly single, open.

Vessel lines: Rather fine, but distinct; wavy.

Vessel contents: Some gum deposits.

Rays: Very fine; faintly visible on cross section; invisible on tangential; visible, but low and inconspicuous, on radial.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: "Quebracho blanco" is readily distinguished from "quebracho colorado" (*Schinopsis*) by its lighter color, open pores, diffuse parenchyma, and absence of canals in the rays; from the "peroba rosa" group by its larger pores and more conspicuous vessel lines, greater density, and the arrangement of parenchyma. The rays are larger, mostly three or four cells wide and 15 cells high, with tendency to heterogeneous; crystals abundant.

Material: Yale Nos. 905, 957, 975, 1071 (Arg.); 4381 (Par. Chaco); 4751 (Matto Grosso, Braz.).

"PEROBA ROSA" GROUP

"Peroba" is the name of a highly important group of Brazilian woods which are comparable in general utility to our oaks. Entire buildings are often constructed of this timber—sills, framing, flooring, interior finish, sash, and doors—while the same material is employed for the furniture.

There are many different kinds and varieties of "peroba" and there is much confusion regarding their identity. They may, however, be referred to two groups, namely, (1) the "peroba rosa" group, of which the type is *Aspidosperma polyneuron* Muell. Arg., and (2) the "ipé peroba" group, which undoubtedly belongs to the Bignoniaceae. The former is the "peroba" of the São Paulo region, the latter of the coastal forest of Rio de Janeiro and Minas Geraes. "Peroba rosa" is a rose-yellow wood; "ipé peroba" is a yellow-brown wood of an entirely different structure. (See Bignoniaceae.)

"Peroba rosa" is one of the largest trees of Brazil, attaining a height of over 125 feet with large straight trunks often four or five feet in diameter. Pereira[227] says: "The timber of the 'perobas' represents an enormous wealth to the State of São Paulo. It is used in all kinds of building construction, both civil and naval, and is in great abundance.

227 Pereira, Huascar: *The timber trees of the state of São Paulo, Brazil,* pp. 68-69.

The slender trees, with their sparse foliage and wrinkled bark, stand out in the landscape clearly marked by their majestic appearance." According to the same author (p. 67) various colors of the woods are indicated by their names, thus, "peroba preta" with conspicuous black veins; "peroba miuda," red with darker patches; "peroba do campo";[228] "peroba poca," a white wood; "peroba rajada," color light red with large black patches; "peroba tremida," yellow with lighter patches almost golden; "peroba reversa," dark-colored with contorted grain. The last, called also "peroba revessa," owes its color and peculiar grain to an abnormal structure somewhat of the nature of bird's-eye in maple.

Aspidosperma polyneuron Muell. Arg. is said to grow in Misiones, Argentina, and the Matto Grosso region of Brazil, where it is known as "palo rosa." The trees are rarely over 50 feet high, though the trunks are sometimes 30 inches in diameter. The wood (Yale No. 4748) is hard, heavy, compact, fine-textured, and of a rose-yellow color, much like some of the grades of "peroba rosa" grown farther east. (Plate XLVI.)

In the State of Bahia is a tree called "quina," which has been identified from leaf specimens collected by Mr. Curran as *Aspidosperma* sp. The trees attain a height of about 80 feet and a diameter of 16 inches and rarely occur in greater frequency than one per acre on the average. The wood (Yale Nos. 1937, 3949) is hard and heavy, rather harsh, and of the typical rose-yellow color. It differs from the wood of *A. polyneuron* in being somewhat harder, harsher, and not so fine-textured, and also has parenchyma in numerous fine, but fairly distinct, concentric lines. It appears to be identical with a specimen (Yale No. 3226) obtained from Espirito Santo, Brazil, under the name of "páo pereira" or "páo paratudo." The former name is commonly applied to *A. macrocarpon* Mart.

Another wood, called "amargoso," comes from the region of Bomjim, Bahia. The specimens available (Yale Nos. 3401, 3413, 3429, 3516) are hard, heavy, fine-textured, the sapwood yellow with pinkish streaks, the heart brown or rosy-brown, with a decidedly bitter taste which presumably gives rise to its name. From the structure of the wood this is presumably a species of *Aspidosperma*. The "amargoso" of Venezuela is *A. lucentivenium*, according to Pittier.[229] A wood (Yale No. 3315) having a similar color and a bitter taste, though somewhat softer and not so fine-textured, was obtained by Dr. Whitford at a sawmill in Santa Catharina, Brazil, under the name of "cainga."[230]

[228] A specimen bearing this name in the Yale collection (No. 703) belongs to the "ipé peroba" group.

[229] Pittier, H.: *Esbozo de las formaciones vegetales de Venezuela*, 1920, p. 8.

[230] This name is also applied to *Mimosa* sp. (Leguminosae).

Although the woods of this group show variation and are the product of several distinct species, nevertheless they have many features in common. Since authentic specimens of the wood of *Aspidosperma polyneuron* Muell. Arg. are available, it is described as the type for the group.

THE WOOD

Aspidosperma polyneuron Muell. Arg. *Peroba Rosa.*

Common names: See foregoing text.

General properties: Color variable and usually variegated; rose-red or yellowish, often with purplish streaks or patches; surface becomes yellowish-brown to dark brown upon exposure; luster rather dull. Sapwood not sharply defined.

Odorless; taste rather bitter.

Moderately hard and heavy, but with considerable variation. Average sp. gr. (air-dry) 0.70. Weight about 43 lbs. per cu. ft. Grain straight to cross or roey. Texture fine and uniform. Wood easy to work, takes a good polish, strong, but rather brittle; durability doubtful.

Growth rings: Present, but often indistinct; due to slight differences in density and color and sometimes also to narrow poreless zones.

Parenchyma: Not visible.

Pores: Minute; not individually distinct without lens; thin-walled and angular; very numerous, crowded; without definite arrangement.

Vessel lines: Fine and inconspicuous.

Vessel contents: None observed.

Rays: Very fine; barely visible on cross section; invisible on tangential; very fine, but distinct in proper light, on radial, being of the same color as or darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: In general like that of *Aspidosperma Vargasii* C. DC. (described below), except that the cells are coarser, the rays are mostly biseriate, and parenchyma is somewhat more abundant.

Material: Yale Nos. 686, 693, 700, 707, 2515, 2516, 3102, 3171, 3213, 3259*, 3297*, 3310, 3533, 3903, 3904, 3905 (Braz.). Asterisk indicates botanical material.

"PEQUIÁ" OR "GUATAMBÚ" GROUP

The woods in this group are more or less of the boxwood type and are characterized by a clear yellow color and a very fine and uniform texture, which gives them value for carving and turning. An important structural feature is the presence of fine, but distinct, concentric lines of wood parenchyma, which are usually so spaced as apparently to limit seasonal growths.

One of the densest of these woods is the "amarillo" of the thorn forests of the dry coastal region of Venezuela, *Aspidosperma Vargasii* C. DC. It was formerly exported as one of the so-called West Indian boxwoods,[231] but has been nearly if not entirely superseded by the "zapatero," *Casearia praecox* Gris. (Flacourtiaceae), which comes from the Maracaibo region. These two woods bear considerable resemblance, but in the "zapatero" the wood parenchyma is absent or very rare, though light-colored lines may be present which upon casual observation appear to be parenchyma. The inner bark of the "amarillo" is not laminated and does not "bleed" and discolor the edge of the wood on the ends of logs, as is the case with the "zapatero." As to minute anatomy: The vessels are isolated, the larger ones 0.06 to 0.07 mm. (tang. diam.); perforations simple; pits small, with apertures often extending beyond borders. Rays homogeneous or nearly so; mostly uniseriate and one to 20 cells high; pits into vessels half-bordered. Parenchyma diffuse or rarely in short tangential lines near limits of growth rings; not abundant. Fibers with tendency to radial arrangement; without gelatinous layer; pits distinctly bordered. *Material:* Yale Nos. 2670, 4423. (Plate XLIV.)

A Brazilian wood of the boxwood class is *A. eburneum* Fr. Allem., variously known as "pequiá marfim" and "páo setim," names which are also applied to certain of the Rutaceae. The tree grows in northern São Paulo and Victoria and is said to attain a height of 50 feet and a diameter of 30 inches. It is of rare occurrence, however, and the wood, though well known locally, is available only in very limited quantities. It is highly prized for fancy articles of turnery, cabinetwork, and inlay, and seems well adapted for mathematical scales and also for engraving purposes.

Of similar structure, but somewhat lighter and softer, is the timber known as "pequiá" in the Bahia region and "guatambú" in São Paulo. The exact botanical status of this wood, or group of woods, has not been established. According to Navarro de Andrade and Vecchi,[232] the common "guatambú" of São Paulo is *Aspidosperma macrocarpum* Mart. (= *A. macrocarpon* Mart.), while in the Serra da Cantareira this name is applied to *A. Sellowii* Muell. Arg. According to Löfgren,[233] *A. macrocarpon* is known as "páo pereira." He mentions "guatambú" in connection with several species of the "peroba" group ("*A. polyneuron, nobile, tomentosum, passiflorum*, etc."), without reference to any one of them in particular. Dr. Whitford collected fruiting specimens of the "guatambú" in Paraná, Brazil, and these have been identified as *Aspido-*

[231] See Record, S. J.: Boxwoods of commerce, *Bul. Tor. Bot. Club,* 48: 297-306.
[232] *Les bois indigènes de São Paulo,* 1916, pp. 163-164.
[233] Löfgren, Alberto: *Manual das familias naturaes phanerogamas,* 1917, p. 435.

sperma tomentosum Mart. (Collector's No. 126; Yale No. 3298). The trees were growing at an altitude of about 2500 feet, were from 65 to 100 feet high and from 30 to 36 inches in diameter.

The various wood specimens indicate considerable variation in density, some of them closely approaching the boxwood class, others being only moderately hard. The color is of various shades of yellow with lemon predominating; the peculiar rose coloration of the "peroba rosa" group is wanting. The timber is fairly plentiful and widely distributed and is used for a great many purposes in both civil and naval construction, where not in contact with the ground. It takes a high polish and is suitable for furniture and cabinetwork. The harder grades make excellent flooring and are also used in turnery. Railway ties of this timber are rated third-class and last only about five years.

THE WOOD

Aspidosperma tomentosum Mart. *Guatambú.*

Common names: Guatambú, guatambú amarello, pequiá (or piquiá), pequiá amarella, peroba amarella (Braz.); lemon wood.

General properties: Color mostly bright, clear canary-yellow; the softer specimens are dull; the denser, lustrous. Sapwood lighter, not clearly defined.

Odor and taste absent or not distinctive.

Variable from hard and heavy to only moderately so. Average sp. gr. (air-dry) 0.77. Weight about 48 lbs. per cu. ft. Grain mostly straight. Texture very fine; harder grades resemble boxwood; easy to work and carve; takes high polish; does not appear durable.

Growth rings: Present; usually clearly defined by very fine line of terminal parenchyma and sometimes also by slight differences in density and color; sometimes plainly visible on tangential surface.

Parenchyma: In fine concentric lines, sometimes double, apparently limiting growth rings; usually visible without lens.

Pores: Pores minute; not individually distinct without lens; numerous; well distributed. There seems to be a tendency at times for the formation within growth rings of concentric zones, in which there is considerable variation in the relative abundance of pores.

Vessel lines: Very fine and inconspicuous.

Vessel contents: None observed.

Rays: Very fine; faintly visible on cross section; invisible on tangential; visible, but inconspicuous, on radial.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Similar to that of *Aspidosperma Vargasii* C. DC., previously described.

Remarks: Distinguished from "peroba rosa" group by color and concentric parenchyma lines; from "quebracho blanco" by color, size of pores, and

arrangement of parenchyma; from miscellaneous group by arrangement of parenchyma.

Material: Yale Nos. 675, 2498, 3111, 3153, 3237, 3266*, 3298*, 3412, 3513, 3524, 3525, 3553, 4723, 4724, 4725 (Braz.). Asterisk indicates botanical material.

MISCELLANEOUS

Two woods which do not fit into any of the foregoing groups are the "carreto" of Colombia and Argentina and the "yaruru" or paddle wood of British Guiana. The latter, which is said to be *Aspidosperma excelsum* Benth.,[234] is a tree of unusual form, in that the timber is composed largely of long, thin, plank-like buttresses radiating from a small central core. The wood is of a yellowish-brown color, moderately hard, heavy, and compact, fairly straight-grained, fine-textured, tough, and strong. The pores are small, faintly visible, fairly numerous, but not crowded, well distributed, occurring singly for the most part. The parenchyma is in numerous fine, closely spaced tangential lines of various lengths, distinct under the lens. The rays are very fine, faintly visible on cross section, invisible on the tangential, not very distinct on the radial surface. Because of the peculiar growth of the tree the wood is little used except by the Indians, who cut paddles for their canoes from the buttresses. The central cores are said to make excellent rollers for cotton gins.

The Venezuelan and Colombian trees belonging to *Aspidosperma* are locally known as "carreto." Two wood specimens (Yale Nos. 324, 347) from Venezuela, unaccompanied by herbarium material, appear to belong to the "peroba rosa" group. They differ materially in structure, color, and other properties from material (Yale No. 405) of this name collected in the forest of the Magdalena Valley of Colombia. The herbarium material, which has been identified only as to genus, consists of slender twigs with numerous willow-like leaves and small velvety fruit pods. The wood, which in dry condition is nearly colorless, is said by the collectors to have been reddish or rose-colored when freshly cut. It is hard, heavy, strong, cross-grained, rather harsh and splintery, inclined to warp and split, and not easy to work. It is reported as being highly resistant to decay, but there is nothing in the appearance of the material to indicate that such is the case. The wood is of about the consistency of "quebracho colorado" and the arrangement of the parenchyma is similar, but the pores are very much smaller and the vessel lines are indistinct.

The following information is furnished by Mr. Curran: " 'Carreto'

[234] The "canalete" of Venezuela and Colombia is said to be this species, but the specimens in the Yale collections are *Cordia* sp. (Borraginaceae).

is perhaps the best known and most widely used timber for heavy bridges, railroad ties, and house posts in the Magdalena Valley, at least in the lower portions. The tree is a constant factor in the forests on the lower slopes of the hills on sites intermediate between those occupied by 'tolú' (*Bombacopsis*) and 'cedro' (*Cedrela*) and the higher slopes where the 'albarco' (*Cariniana*) is found. Over certain limited areas it is very abundant, being apparently gregarious in small groups. One may pass along a trail and count 10 to 15 trees per acre and a little further on not encounter any. The tree grows to a height of over 100 feet with a slender cylindrical bole having clear lengths of 50 to 60 feet and diameters of two to three feet. The bark is light-colored, smooth, and beech-like, the crown is narrow and the branches are rather small. The wood is heavy and hard and highly durable in contact with the soil. 'Carreto' is not so well known or so extensively used in Venezuela, but a certain amount of the timber is obtained from the forests of the Lake Maracaibo region and is used for the same purposes as in Colombia." *Material:* Yale No. 1524; Curran's No. 294.

70. BORRAGINACEAE

The Borrage Family consists of about 90 genera and approximately 2000 species, mostly herbaceous plants, widely distributed and most abundant in temperate regions, especially in the Mediterranean Basin and in central Asia. Many of the plants are cultivated for decorative purposes (*e.g.*, the heliotrope), some bear edible berries, and some have medicinal or other special properties of value. A few tropical genera are arborescent and yield woods of commercial importance.

As to the minute anatomy of the three genera described below: The vessels have simple perforations; the inter-vascular pits are rather small. The rays vary in width up to six or seven cells, commonly four or five, and in height from few to 100 cells, being largest in *Cordia;* in *Patagonula* they are homogeneous or nearly so; heterogeneous in *Auxemma* and *Cordia;* in the latter genus there are often very large cells along either side, as well as on the margins and interspersed; crystals are common. Parenchyma is abundant and coarse-celled. The wood fibers have very small simple pits. According to Solereder,[235] isolated reticulate perforations of the vessels have been observed in *Cordia Myxa* L., and perforated bordered pits with broadly elliptical openings which cross each other in the narrower vessels of *Lithospermum fruticosum* L. In this last species the small vessels are sometimes spiral, as are also the fiber-tracheids. The fibers have bordered pits in species of *Tournefortia, Lithospermum, Ehretia, Heliotrium,* and *Echiochilon.*

235 Solereder, Hans: *Systematic anatomy of the dicotyledons,* Oxford, 1908, p. 561.

CORDIA

This genus, the most important of the family, consists of about 350 species of trees and shrubs inhabiting the tropical and warm extra-tropical regions of the world. The genus is represented abundantly throughout tropical America and, while most of the species are shrubs or small trees, some of them are important timber trees. The woods exhibit much variation in density and color, but have certain general characteristics which make them readily recognizable. The rays are very distinct on tangential surface, the texture varies from moderately to decidedly coarse, and the surface of the wood looks mealy and dull or of a golden luster, depending upon the angle of vision. The color varies from grayish-yellow or yellowish-brown to dark brown, variegated with black. The range in density is from light, soft, and spongy to decidedly hard and heavy, the densest being also the darkest. It is possible, therefore, to classify them into two general groups, though there are intermediate forms whose reference to either group is largely arbitrary.

THE DARK-COLORED CORDIAS

These are cabinet woods primarily. They are hard and heavy, richly variegated with various shades of brown and irregular markings of purple or black, and with more or less of an oily appearance and feel. Some of the material is mildly and pleasantly scented. These woods are not the product of a single species, though how many species are involved is unknown. There is also some question as to whether the same species will in all cases yield the same quality of wood. The type specimens of this group are the "ocatillo meco" of Oaxaca, *Cordia elcagnoides* DC. (Yale No. 4762), and the "bocote" of Guerrero, Mexico, *C. gerascanthoides* H. B. K. (Yale No. 4411), both accompanied by herbarium material. The "canalete" of Venezuela and Colombia also belongs here, but the species producing it has not been determined. This wood (Yale Nos. 326, 338, 353, 2762, 4422) is not very oily and has no appreciable odor.

There are also Brazilian woods belonging to this group. A specimen (Yale No. 3411) collected by Mr. Curran in the market of Bomjim, Bahia, under the name of "frei jorge," is hard and heavy and of a dark brown color, quite distinct from the other available specimens of that name which are included in the next group. It may have originated in Pará. Another specimen (Yale No. 4750) comes from southwestern Brazil near the Argentina boundary and is labeled "Peterebí. *Cordia frondosa*." Most of the several specimens of "peterebí" from Argentina are less dense and of lighter color, though some of them show dark

patches. This may be the wood known there as "loro negro." According to Castro,[236] "loro negro" is *Cordia frondosa* (*C. frondosa* Schott = *C. alliodora* Cham.). The heartwood is dark and variegated, the sapwood ashy-white, and the specific gravity is between 0.755 and 0.928; while "peterebí" or "loro amarillo," *Cordia* sp., is a light yellowish wood with little distinction between heart and sap, resembling light-colored walnut (*Juglans*), and having a specific gravity of 0.74 to 0.78. The former is a very common tree in the forests of Misiones, where it attains a height of 50 to 80 feet and a diameter of 20 inches. The wood is used in general construction, cabinetwork, and the manufacture of vehicles. The smaller branches are a source of excellent firewood.

There are woods of this group in the West Indies, but no authentic specimens are available for study. *Cordia Sebestena* L. occurs in southern Florida, most of the Antilles, the northern coast of South America, and in Yucatan, Mexico. In Florida, where it is known as the geiger tree, it attains a height of 25 to 30 feet and has a slender trunk five or six inches in diameter supporting a narrow, compact, round-topped crown. The wood is heavy and hard, with a light brown or yellowish sapwood and dark brown heart. In Porto Rico it is called "vomitel colorado" and "San Bartolomé," and in the British West Indies aloe wood. The "carey de costa" of Cuba is said to be *C. angiocarpa* A. Rich, though the two specimens bearing this common name in the Yale collections are obviously of an entirely different family. The published descriptions, however, indicate *Cordia*. Neville[237] says that the "carey de costa" or tortoise-shell wood is very little known even in Cuba, where it grows on some of the keys bordering the north coast of Camagüey Province, and attains a diameter of eight to ten inches. "The wood is extremely heavy, very dense and fine-grained and capable of taking a brilliant polish, and its heart is many-colored, shades of browns, blacks, and dark yellows merging so that the articles made from it are beautiful indeed."

C. gerascanthoides H. B. K. also occurs in the West Indies and the wood is highly esteemed for cabinetwork, furniture, interior finish, vehicles, and cooperage. The description of the wood of this species is based on an authentic specimen from Mexico.

THE WOOD

Cordia gerascanthoides H. B. K. *Bocote.*

Common names: Bocote, barl (Mex.); pardillo del monte (Venez.); baría,

[236] Castro, Eduardo B.: *Las maderas Argentinas*, Rosario, 1918, pp. 121, 181.
[237] Neville, H. O.: Hardwoods in Cuba. *The Cuba Review*, 18: 1: 21, Dec., 1919.

varía, vería negra, vería prieta (Cuba). Similar woods: Ocatillo meco, anacahuite, guayabillo ?, copté, siricote (Mex.); canalete (Venez., Col.); loro negro (Arg.); lauro pardo, lauro preto (Braz.); mahot noir ? (Guad.); carey de costa, tortoise-shell wood (Cuba); aloe wood (B. W. I.); vomitel colorado, San Bartolomé (P. R.); geiger tree (Fla.); black sage ?, bois negre ?, cariaquita negra ? (Trin.).

General properties: Variegated; various shades of brown with irregular black marking; oily or waxy appearance and feel. Sapwood gray; sharply defined, though often with irregular inner margin.

Odor mildly fragrant in oiliest specimens.

Very hard and heavy. Sp. gr. (air-dry) 0.97. Weight about 60 lbs. per cu. ft. Grain fairly straight to somewhat roey. Texture medium. Wood tough and strong, rather difficult to cut, not easy to split, takes a smooth finish, looks highly durable. The black portions are horn-like; harder than rest of the wood.

Growth rings: The variations in color are sometimes regular enough to appear as rings of growth; true growth rings sometimes limited by fine line of parenchyma.

Parenchyma: About the pores and sometimes joining them into diagonal or irregular tangential rows; also occasionally in concentric lines of varied spacing.

Pores: Numerous; usually distinct; fairly well distributed; occurring singly or more often in groups of few to several, arranged radially or tangentially; mostly closed.

Vessel lines: Fine; inconspicuous; distinct in proper light, due to parenchyma sheathes.

Vessel contents: Tyloses abundant; gum deposits common.

Rays: Rather narrow, but distinct, on cross section; faintly visible on tangential; distinct, but not conspicuous, on radial.

Ripple marks: Absent.

Gum ducts: None observed. Likely to occur as result of injury.

Remarks: This wood is almost identical with that of *Cordia eleagnoides* DC. (Yale No. 4762). The other woods of this group, as far as examined, have no distinct odor, are only slightly oily, the rays are much higher, show conspicuously on radial surface and provide planes along which cleavage is easy.

Material: Yale No. 4411 collected with leaves and flowers by Mr. John A. Gamon in San Luis la Loma, Guerrero, Mexico. For others of this group, see text above.

THE LIGHT-COLORED CORDÍAS

These are woods of general utility. They range in density from light, soft, and spongy to moderately hard and heavy. The color varies from yellow, often with a golden luster in proper light, to various shades of brown, sometimes variegated. The sapwood, though fairly clearly defined, exhibits little contrast from the heart. The woods lack the con-

spicuous figure and richness of color of the other group, but are apparently more abundant and of greater economic importance.

The "peterebí" of Argentina belongs to this group, though the name is also applied to other species of *Cordia* with dark woods. Mr. Curran says:

"Peterebí" is a symmetrical tree 100 to 125 feet high with a slender trunk usually 18 to 24 inches in diameter and free of branches for 40 to 50 feet. It is without buttresses, and the bark is dark brown and rough, suggesting elm (*Ulmus*). The deciduous leaves are rather thin and about two inches long and one inch wide; the flowers are dark chocolate-brown and borne in great profusion at the extremities of the branches.

Though nowhere abundant, this tree is common in the forests of Misiones, Argentina, and in Paraguay and the adjacent region of Brazil. It occupies the sandy or clay loam in the vicinity of the rivers and the best stands rarely contain more than two or three trees per acre. The timber reaches the market in the form of squared logs and the total amount consumed annually is between 500,000 and 1,000,000 board feet. The wood, which is of a golden brown color, is considered one of the best furniture woods in Argentina.

Castro says (*loc. cit.*, p. 18) that the "peterebí" or "loro amarillo" (*Cordia* sp.) is found in Misiones and northern Corrientes, and is from 50 to 80 feet high and about 20 inches in diameter. The wood is used for general construction, cabinetwork, furniture, and door and window frames. It is easy to work and has a high luster and is proving a satisfactory substitute for European oak for the manufacture of furniture.

In discussing the woods of the Amazon region of Brazil, Huber[238] says: "The genus *Cordia* includes many species which furnish woods that are very strong, homogeneous, and easy to work, not only in southern Brazil, where they are known under the names of 'louro' and 'claraiba,' but also in other tropical countries. Here we have several arborescent species of *Cordia*, of which the most important is *Cordia Goeldiana* Huber, commonly called 'frei jorge.' This species, which is remarkable on account of its very dense clusters of rather large and lasting flowers, is a big tree of the forest of the Bragança Railway and probably also of other parts of the state. Its wood, though not of first quality, is highly regarded, especially for barrels and pails."

The wood of "frei jorge" or "frei-jo" is of a uniform yellowish-brown color, or with slightly darker striping, and with a golden luster in proper light, but dull and mealy otherwise. It has a specific gravity (air-dry) of 0.60, weighs about 37 lbs. per cu. ft., and is strong, straight-grained, rather coarse-textured, easy to work, splits readily

238 Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:201 (1909).

along the rays, and takes a good finish. The rays are high, of lower luster than the background, producing silver grain on quarter-sawn material. Rows of vertical gum ducts, presumably due to injury, are occasionally found. The wood is very much like the "peterebí" of Argentina, though of somewhat coarser texture and higher luster. The timber is being exported to Europe for cooperage. During the war sample logs were shipped to the United States for trial for gunstocks and airplane propellers, under the name of Brazilian walnut. It is now being used in limited quantities in the United States as a walnut substitute in furniture, instrument boards of automobiles, etc.

One of the best known and most widely distributed species of *Cordia* is *C. Gerascanthus* L. with a range extending from the West Indies through northern South America and Central America into Mexico. It grows as isolated individuals or in small clumps on hillsides or well-drained flats, and is from 30 to 75 feet high and from 18 to 24 inches in diameter. In this, as in certain other species of *Cordia*, the forks of the young twigs have a hollow swelling which harbors predacious ants. The wood, though not heavy, is firm and strong and extensively used in some places for interior construction, carpentry, furniture, and cooperage.

THE WOOD

Cordia Gerascanthus L. *Laurel.*

Common names: Laurel (C. A.); bojon, baría, bohom, habeem (Mex.); solera (Col.); pardillo, caujaro (Venez.); cyp, cypre, pardillo (Trin.); bois de cypre, bois de cype (Mart.); bois de rose, faux bois de rose, bois de Rhodes, cipre (Guad.); baría, varía (Cuba); capá (P. R.); prince wood, Spanish elm, Dominica rosewood (B. W. I.). Similar woods: Anacahuite, trompillo, palo asta, cueramo, candelero (Mex.); varilla negra, zapotele (C. R.); tigüilote, laurel, laurel blanco (Salv.); niguito, sumwood ?, samwood, caparo ? (Pan.); guasimo nogal (Col.); caujara, pardillo blanco (Venez.); cyp savanne, alatrique, savanna cyp (Trin.); karawara (Curaçao); sebastier, bois Marguerite, bois parasol (Fr. G.); achira-mourou (Galibis); mapou blanc, cipre oranger, cipre balanic, cypre à griver (Guad.); ateje amarillo, ateje macho, varía blanca, uva gomosa, atejillo (Cuba); cereza, cereza cimarróna, muñeca, palo de muñeca, moral, moral de paz (P. R.); clammy cherry (Jam.); louro, louro amarello, frei jorge, frei-jo, capueiro, claraiba, claraiba das algoas, clarahiba, barba de boi, páo cachorro, mata fome, parapará, babosa branca, arvore de umbella, pinchiricóto, páo do formige (Braz.); peterebí, petereby, afata grande, lapachillo, araticú, araticú guazú, colita, gomita (Arg.).

General properties: Color yellow to brown; often more or less streaked; luster usually high in proper light, otherwise dull.

Without distinct odor or taste.

Rather light and soft, but firm, to moderately heavy. Sp. gr. (air-dry) 0.61.

Weight about 38 lbs. per cu. ft. Grain mostly straight. Texture coarse. Wood tough and strong for its weight, seasons readily without serious checking or warping, easy to work, finishes fairly smoothly, not very durable in contact with ground.

Growth rings: Indistinct to very distinct; sometimes limited by parenchyma, sometimes indicated by differences in density, in color, and in size of pores.

Parenchyma: About pores and sometimes uniting them laterally; fairly distinct on moist cross section; sometimes in tangential lines of variable length.

Pores: Rather small, numerous; fairly well distributed; occurring singly or in small groups; sometimes with tendency to diagonal or concentric arrangement in outer portions of growth rings; mostly closed; some specimens with row of larger pores in early wood.

Vessel lines: Fine; usually wavy; fairly distinct in proper light on account of parenchyma; some may be darker than background due to gum content.

Vessel contents: Tyloses abundant; gum or oily substance in dark-colored areas.

Rays: Numerous, uniform, and very distinct on cross section; visible on tangential; rather high and conspicuous on radial surface, somewhat as in black cherry (*Prunus serotina* Ehrh.); cells on radial section visible under lens, showing decidedly heterogeneous character of rays.

Ripple marks: Absent.

Gum ducts: Rows of vertical ducts occasionally present as result of injury.

Remarks: Some of the woods of this group resemble elm (*Ulmus*) in structure and general properties. The inner bark separates into many thin layers.

Material: Yale Nos. 2956* (collected by Pittier in Panama; his No. 5279); 3689*, 3704* (collected by Messrs. Whitford and Stadtmiller in Guatemala, with leaves and flowers); 1548* (Col.). Other material in this group: Yale Nos. 2957*, 6741 (Pan.); 3740* (Guat.); 4371 (C. R.); 510, 1548, 2615 (Col.); 439*, 470, 4416, 6674 (Venez.); 577 (Trin.); 2766 (Curaçao); 2041 (B. G.); 3225, 3428, 3593*, 3934, 4104, 4705, 4718 (Braz.); 913, 923, 1032, 1079, 1710*, 1729, 1738, 4128, 4398 (Arg.). Asterisk indicates botanical material.

PATAGONULA

Of the three known species of this genus, which is largely confined to Brazil and Argentina, only the "guayabí," *Patagonula americana* L., is a timber tree. It is fairly common in northern Argentina, where it is said to attain a height of 65 to 70 feet and a diameter of 24 inches. It has a thick, light-colored sapwood and a very dark, usually beautifully variegated heart of irregular contour, which in some specimens bears a superficial resemblance to figured red gum (*Liquidambar*). Owing to its strength, toughness, and elasticity the sapwood is well

suited for the manufacture of tool handles, oars, agricultural implements, ox-yokes, and vehicles. The Indians of Misiones use it for their bows. The heartwood is highly durable and fallen timber from which the sapwood has rotted away is often cut into lumber of excellent quality. It is highly esteemed for fine furniture, cabinetwork, interior finish, turnery, and fancy articles.

THE WOOD

Patagonula americana L. *Guayabí.*

Common names: Guayabí (or guayaybí), guayabí amarillo, guayabí blanco, guayabí morotí, guayabí negro, guayabirá, guayaibirá, guayubirá, guayabirá amarillo, guayabirá blanco, guayabirá crespo, guayabirá negro, cuayabí (Arg.); guajuvira, guajuvira branca, ipé branco (Braz.).

General properties: Color usually variegated; many shades of brown to purplish-black; sometimes fairly uniform dark olive. Thick sapwood gray or grayish-brown; sharply defined. Luster not pronounced.

Odor and taste not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.85 to 0.95. Weight 53 to 59 lbs. per cu. ft. Grain fairly straight. Texture rather fine. Wood fairly easy to work, takes a high polish, is tough, strong, resilient; the heartwood is highly durable.

Growth rings: True growth rings present, but not distinct; due to more orderly arrangement of the elements; darker bands sometimes regular enough to give appearance of growth rings.

Parenchyma: Associated with the pores and joining them tangentially.

Pores: Small, not individually distinct without lens; numerous; open; arranged in numerous irregular to fairly regular distinct tangential or concentric lines or bands suggesting elm (*Ulmus*).

Vessel lines: Very fine, but distinct in proper light; producing fine pattern on tangential surface, due in part to the lower luster of the associated parenchyma.

Vessel contents: None observed.

Rays: Very fine; scarcely visible on cross section; invisible on tangential; distinct, but not conspicuous, on the radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: In color and figure this wood bears some resemblance to the darker-colored specimens of *Cordia*, though it differs in the size and arrangement of the pores, the finer texture, and the much smaller rays, which are homogeneous. The inner bark is in thin laminations. Three specimens (Yale Nos. 1038, 1039, 1048) obtained from Argentina under the name of "guayabí" are *Phyllostylon* (Ulmaceae).

Material: Yale Nos. 1057, 1688*, 1706*, 1732, 3994, 4375 (Arg.); 4757 (Matto Grosso, Braz.). Asterisk indicates botanical material.

AUXEMMA

The best known of the two species of this Brazilian genus is *Auxemma Gardneriana* Miers (= *A. onococalyx*). This is a medium-sized to large deciduous tree with its center of distribution in Ceará, where it grows gregariously and rather abundantly in the regions with distinct wet and dry seasons. The olive-like fruit is completely enclosed in a five-winged bladder formed by the inflated calyx-tube. The wood is extensively used by the natives for fuel. The common name is "páo branco" (white wood), but this presumably refers to young trees which have not developed heartwood. The specimen available closely resembles black walnut (*Juglans nigra* L.) and this agrees with Löfgren's[239] statement that the timber is of good quality and has a dark-colored durable heartwood.

THE WOOD

Auxemma Gardneriana Miers — *Páo branco.*

Common name: Páo branco (Braz.).

General properties: Color deep chocolate or purplish-brown; somewhat variegated; surface becomes light brown upon exposure; lustrous. Sapwood yellowish-white, sharply defined.

Odor and taste not distinctive.

Heavy and hard. Sp. gr. (air-dry) 0.70. Weight about 43 lbs. per cu. ft. Grain straight. Texture coarse. Wood strong, easy to work, finishes smoothly, looks highly durable.

Growth rings: Distinct, due to zone of larger pores; ring-porous.

Parenchyma: About pores and pore groups; mostly in late wood, where it tends to join pores irregularly and sometimes produces short irregular tangential lines; fairly distinct under lens, but inconspicuous or indistinct otherwise.

Pores: Variable from rather large and very distinct to minute; the larger in a ring or irregular zone in early wood of growth ring; those in late wood irregularly grouped; mostly open.

Vessel lines: Distinct, but not conspicuous; mostly long and straight. Vessel segments show very clearly under lens.

Vessel contents: Some dark-colored tyloses present.

Rays: Fine, but distinct, on cross section; faintly visible on tangential; more or less conspicuous on radial surface, appearing of same color or lighter than background; some rather high.

Ripple marks: Absent.

Gum ducts: None observed.

Remarks: Has the luster and distinct rays of *Cordia,* but differs chiefly in

[239] Löfgren, Alberto: *Contribuicões para a questão florestal da região do nordéste do Brazil,* Rio de Janeiro, 1912.

being ring-porous. The pith is somewhat chambered. Is much more like *Cordia* than *Patagonula.*

Material: Yale No. 3363 collected by Mr. Curran in Ceará, Brazil.

71. VERBENACEAE

The Teak Family consists of about 75 genera and some 1300 species, mostly herbaceous plants, of very extensive distribution. Some of the tropical representatives are trees, of which the best known is teak, *Tectona grandis* L.f., of southeastern Asia and the Malay Archipelago. There are several arborescent genera in tropical America, but most of the trees are small and of slight commercial importance. The most common of these are *Citharexylum, Petitia, Vitex,* and *Avicennia.*

CITHAREXYLUM

Citharexylum (*Citharexylon*) embraces about 75 species of tropical American trees and shrubs. The fiddlewood of Florida, *C. villosum* Jacq., has very heavy, hard, fine-textured wood of a clear, bright, reddish color. The common name fiddlewood, which is also the basis of the generic name, is a corruption of "bois fidèle," a term applied to the wood by the early French colonists of the West Indies in allusion to its strength and toughness. The "roble amarillo" or "palo guitarra" of Cuba, *C. lucidum* C. & S., is sometimes cut into lumber for local uses and round stems are employed for props and in rough construction. The "pombeira" or "páo de viola" of southern Brazil, *C. cinereum* L., is a very common tree, usually of medium size, but sometimes attaining large dimensions, which supplies wood used for fancy boxes and musical instruments, and said to be suitable for paper pulp. The name "tarumá" is applied to species in the Amazon region.

The "iguanero" of Panama, *C. macrochlamys* Pittier, is a forest tree 75 to 90 feet high with a straight trunk sometimes 20 inches in diameter, but is little used. *C. barbinerve* Cham. is a very common tree in northern Argentina, where it sometimes reaches a height of 50 feet and a diameter of 18 inches. The wood is said to be nearly white throughout, moderately soft, easy to work and used to a limited extent in carpentry, and for boxes and miscellaneous purposes not demanding great strength or durability. The local names of this tree are: Espina de bañado, tarumá con espinas, tarumá espinudo, aguay-guazú, and coronillo colorado.

PETITIA

This genus consists of only two or three species, occurring in the West Indies and Mexico. *Petitia domingensis* Jacq. (= *P. Poeppigii*

Sch.) is found on the pine-barrens, coppices, and scrub-lands of the Bahamas, where it reaches a height of 65 feet, though usually it is much smaller and sometimes is a shrub. In Porto Rico it is a tree 20 to 50 feet high, sometimes two feet or more in diameter, and supplies timber used locally in making rollers in the coffee-hulling mills. In Cuba this tree is scattered rather widely on the higher lands and, while not uncommon, is nowhere abundant. The tree grows to fairly large size and the wood is highly esteemed for making carts, and also for general carpentry, fence and house posts, and piling. It is suited also for cabinetwork, furniture, and interior finish.

THE WOOD

Petitia domingensis Jacq. *Fiddlewood.*

Common names: Fiddlewood (B. W. I.); roble guayo (Cuba); capá, capá blanco, capá sabanero, capá de sábana, capá amarillo (P. R.); capá de sábana (S. D.); capá (Curaçao); petitia, bastard stopper (Jam.).

General properties: Color light brown with dark striping; lustrous; darker portions appear waxy. Sapwood grayish. A beautiful wood when finished properly.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.95. Weight about 59 lbs. per cu. ft. Grain roey and sometimes finely wavy. Texture rather fine. Wood easy to work, takes a high polish, appears fairly durable.

Growth rings: Present and sometimes very distinct due to color contrasts.

Parenchyma: Indistinct; associated with pores in small amount and sometimes in narrow line at limit of growth ring.

Pores: Small, but visible; mostly closed; numerous, but not crowded; well distributed; occurring singly or sometimes in groups as though subdivided radially two to three times.

Vessel lines: Fine, but distinct; mostly short on account of roe grain.

Vessel contents: Tyloses abundant.

Rays: Very fine; faintly visible on cross section; invisible on tangential; low, but distinct, on radial surface, where they appear either lighter or darker than background, depending on the light.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits large. Rays mostly heterogeneous; variable in size; one to three cells wide and few to 20 cells high; pits into vessels rather large, simple or in part half-bordered. Fibers with small simple pits.

Material: Yale Nos. 802, 5011 (Cuba); 2685 (P. R.); 5035 (S. D.).

VITEX

This genus is very widely distributed throughout the tropics and contains many species, some of which are large trees. The "puriri" of

New Zealand, *Vitex littoralis* A. Cunn., is considered the strongest and most durable timber supplied by that country. *V. altissima* L.f. is a very important tree in southern and western India and in Ceylon, where it attains large dimensions, the diameter being upward of six feet. The "moláve" of the Philippines, *Vitex parviflora* Juss., is more highly esteemed and more variously used than any other wood of the Islands, with the exception of "narra" (*Pterocarpus indicus* Willd.).

The "tarumá" of northern Argentina, *Vitex* sp., is a common tree, usually less than 50 feet high, but sometimes three feet in diameter. The fruit is edible and has an agreeable flavor. The wood is of a dark ashy-gray color, rather hard, easy to work, and durable; it is used locally for general construction, shipbuilding, carpentry, and turnery.

Vitex divaricata Sw. is a tree 30 to 60 feet high and from 20 to 30 inches in diameter in the mountainous regions of Porto Rico and is common to many of the islands of the Lesser Antilles. The wood is used locally for framework of houses, general carpentry, and in cabinetwork.

There are several species in Central America, but their woods are not extensively used. The type described below was collected along the Guatemala-Honduras boundary and has the general structure of other species, so far as material is available for comparison, though there is a considerable range in density within the genus.

THE WOOD

Vitex longeracemosa Pittier — *Jocote de Mico.*

Common names: Jocote de mico (Guat.-Hond.). Other species: Rajate bien (Guat.-Hond.); higuerillo, péndula, palo de péndula, péndula blanca (P. R.); lizard wood, fiddlewood (B. W. I.); bois lézard (Mart.); bois gonte, bois lézard (Guad.); bois la morue (Fr. G.); tarumá frondosa, tarumá tuira, mameira, maría preta, turamán do alagado (Braz.); turamán, tarumá, tarumá dura, velame do campo (Arg.); pechiche (Ecuador); capulín (Mex.).

General properties: Color yellowish-brown; somewhat lustrous. Sapwood straw-colored, deepening upon exposure.

Odor and taste absent or not distinctive.

Moderately hard and heavy. Sp. gr. (air-dry) 0.70. Weight 43 lbs. per cu. ft. Grain variable from fairly straight to irregular. Texture medium. Wood rather easy to cut, strong, but somewhat brittle, finishes well, is probably durable.

Growth rings: Distinct or fairly so; due to slight differences in color and density, together with fine line of terminal parenchyma.

Parenchyma: In narrow circles about pores and in terminal lines; not very distinct.

Pores: Small, but visible; numerous, but not crowded; fairly evenly distributed; occurring singly or in radial groups of two to several; sometimes showing tendency to diagonal rows.

Vessel lines: Fine and inconspicuous.

Vessel contents: Tyloses present.

Rays: Fine, but distinct, on cross section; indistinct or invisible on tangential; distinct, but low and inconspicuous, on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; walls finely spiral. Rays heterogeneous in part; two to four cells wide and few to 50 cells high; pits into vessels mostly half-bordered and rather large. Fibers have simple pits; are not septate.

Remarks: In *Vitex floridula* D. & W. from Panama (Yale No. 3023; Pittier's No. 4683) and in *Vitex* sp. from Guatemala-Honduras (Yale No. 3684) the rays are considerably broader, and in the latter specimen the pores are much more numerous, and the fibers are septate. Some of the yellow specimens of *Vitex* suggest satinwood (*Zanthoxylum*), and some of the coarse-rayed brown ones have a superficial resemblance to certain of the Borraginaceae.

Material: Yale No. 3733 collected with leaves, fruit, and flowers along Guatemala-Honduras boundary by Whitford and Stadtmiller.

AVICENNIA

This genus consists of three species of evergreen trees, common along tropical and sub-tropical coasts and in tidal swamps in association with other trees and shrubs of the mangrove formation. Although the trees sometimes attain a height of 60 to 70 feet and a diameter of two feet, they are generally not over 25 feet high and toward the northern and southern limits become low shrubs. The trees have long, heavy roots, which grow in and out of the mud in an arched and entangled manner and also send out asparagus-like leafless branches or aerating roots, which help to form an impenetrable jungle. The close network of roots gathers the mud and the flotsam of the sea and gradually builds up the shores and protects them from the waves. The seed usually germinates on the tree and is growing and ready to take root when it falls into the soft mud.

The woods of all three species are practically identical and are distinct from others of the family in that they contain concentric and anastomosing layers of soft bast, which resembles wood parenchyma. This wood is of negligible economic importance, though used locally for fuel and miscellaneous purposes in the round.

The only species in the western hemisphere is *Avicennia nitida* Jacq. It occurs on both the east and the west coast of southern Florida, in the West Indies, and on the north coast of South America.

THE WOOD

Avicennia nitida Jacq. *Black Mangrove.*

Common names: Black mangrove (Fla., B. W. I.); blackwood, blacktree (Fla.); green turtle bough (Jam.); manglé blanco, manglé bobo, chifle de vaca (P. R.); manglé prieto, manglé negro (Cuba, Venez.); ceriúba, ciriúba (Braz.); bois de mèche (Guad.); paletuvier blanc (Fr. G.); pariva, parwa (Sur.); orozuz (Mex.); arbol de sal, ishtatén, istatén (Salv.).

General properties: Color brown to nearly black, with more or less oily appearance; yellowish powder (lapachol compound) may be present. Sapwood thick, whitish or gray to brownish.

Odor and taste absent or not distinctive.

Heavy and hard. Sp. gr. (oven-dry) 0.91 (Tenth Census). Weight about 57 lbs. per cu. ft. Grain irregular. Texture coarse and uneven. Wood not easy to work; not suitable for lumber on account of laminations of unlignified tissue, which upon disintegration allow the fiber layers to separate.

Growth rings: Conspicuous; due to alternating layers of wood and soft tissue (bast). Just inside the bast layer is a single row of openings (phloem cavities) resembling large pores.

Parenchyma: Wood parenchyma not in evidence. Layers of soft tissue (resembling wood parenchyma) are comparatively narrow.

Pores: Small, indistinct to invisible without lens; occurring singly, subdivided or in short radial rows; not crowded; fairly well distributed. Pore-like openings (phloem cavities) very distinct.

Vessel lines: Fine, wavy, inconspicuous; layer of vessel-like phloem cavities very distinct, conspicuous on tangential surface.

Vessel contents: Yellowish powder (lapachol compound) sometimes present in heartwood. (See description of lapachol under *Tecoma*, p. 538.)

Rays: Very fine; faintly visible on cross section; invisible on tangential; visible, but inconspicuous, on radial surface.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits extremely small. Rays heterogeneous; mostly uniseriate, but widening in bast zones; next to bast zone is a layer of square, sclerosed cells; pits into vessels very small, half-bordered. Fibers thick-walled, with simple pits.

Remarks: Wood with anomalous structure as in certain woods of the Phytolaccaceae.

Material: Yale Nos. 795 (Cuba); 4462 (Florida); 4983 (Bermuda); 3360 (Braz.). Also various specimens of other species from the Old World.

72. BIGNONIACEAE

The Trumpet-creeper Family consists of about 100 genera and several hundred species of wide distribution in tropical regions, a few in temperate zones. A great many representatives are scandent shrubs or woody climbers, one of the best known of which is the trumpet creeper

cultivated in gardens. The stems of many of these consist of wedges of wood and bast, or exhibit other forms of anomalous structure.[240] Many of the plants of the family are noted for the beauty of their showy flowers and are accordingly planted for decorative purposes. There are numerous arborescent genera, a few of which are highly valuable for their timber. Three species are native to the United States, but only one, *Catalpa*, is well known.

The woods exhibit a wide range of variation in their properties; some of them being light and soft, others of medium density, the remainder very hard and heavy and noted for their strength and durability. As to the minute anatomy: The vessels have simple perforations; the intervascular pits are rather large; in a few instances spirals are present. The rays are narrow, often uniseriate and rarely over three cells wide, and mostly under 15 cells in height; generally homogeneous, but with a tendency to irregularity in this respect; the pits into the vessels are small and half-bordered. The wood fibers have simple pits. In certain species of *Tecoma* or *Tabebuia*, all of the elements are in horizontal seriation.

CHILOPSIS

This genus, with two known species, is limited to Mexico and southwestern United States. The desert willow of the region of the United States-Mexico boundary, *Chilopsis linearis* P. DC. (= *C. saligna* Don.), is a small tree with long willow-like leaves and catalpa-like flowers and pods, growing along banks of streams and in depressions in the desert. It is known in Mexico as "mimbre." The wood is yellowish-brown in color, rather light and soft, easy to work, and fairly durable. The structure closely resembles that of the catalpa grown in temperate regions, being more or less ring-porous, the pores in the late wood showing a tendency to tangential arrangement, and all of them filled with tyloses; the small vessels are spiral. The wood is of no commercial importance. *Material:* No. 166, Tenth Census Collection.

CATALPA

There are more than 15 species of *Catalpa*, mostly in the north temperate regions, though there are a few in Mexico, Brazil, and the West Indies. *C. longissima* Jacq. (= *Macrocatalpa longissima* Britton) is a common tree of the island of Haiti. The bark is ashy-gray and at a distance the tree resembles mahogany (*Swietenia*). It constitutes about 90 per cent of the lumber cut in Cape Haitien and Port au Prince, and

240 For detailed information regarding these anomalies see Solereder's *Systematic anatomy of the dicotyledons*, pp. 605-610.

reaches the mills in the form of logs eight to 16 feet long and 12 to 18 inches through. The wood is of light brown color, with a figure suggesting elm (*Ulmus*), is moderately hard and strong, easy to work, and takes a highly lustrous finish. It is used for carpentry, general construction and very generally for flooring. The early French settlers made their furniture of it and many pieces of it are now cherished as beautiful works of art. It is not being exported, although a trial lot of short logs reaches the New York market from Haiti during the war. It would probably prove satisfactory for gunstocks, but the supply is too limited to justify a foreign market. The common names are: Bois chêne (Haiti); roble (S. D.); chêne de Antilles (Mart.); randegonde (Guad.).

Catalpa punctata Gris. (= *Macrocatalpa punctata* Britton) is a tree sometimes 35 feet high in the Bahamas, where it is known as Cuban catalpa. In Cuba it is called "roble de olor" and is said to be used locally for construction and turnery.

JACARANDA

The 60 known species of this genus are mostly Brazilian, though there are representatives in other parts of tropical America. *Jacaranda coerulea* (L.) Gris. attains a maximum height of 40 feet in the Bahamas, where it is known as boxwood, cancer tree, and what-o'clock. It is also reported from Martinique, and from Cuba where it is called "abey macho." The hard white wood is used for carpentry in the rural districts. The names "abey" and "abey macho" are also applied to *J. Sagreana* DC., which occurs throughout Cuba and the Isle of Pines. It is said to attain a height of 25 to 35 feet, and furnishes a yellowish-white wood with a specific gravity of 0.72.[241]

The name "caroba" is applied to various species of *Jacaranda* in Brazil and Argentina. The "caroba" or "para-paraí" of Misiones and Corrientes, *J. Caroba* (Vell.) DC., is a tree 50 to 60 feet high and 20 to 30 inches in diameter. Another Argentine species, *J. acutifolia* H. & B., the "jacarandá" or "tarco," is about 25 feet high and 16 inches in diameter. The woods of these two are much alike and their principal uses are for fuel and charcoal and to a small extent for carpentry. They are light and soft (specific gravity about 0.55), not very strong, straight-grained, fine-textured, brittle, easy to work, finishing smoothly; of a yellowish-white or grayish color with fine brown parenchyma and vessel lines producing a distinct pattern on the tangential surface. The pores are small, but visible, connected tangentially by parenchyma into

[241] *Cuadro sinóptico de la flora maderable cubana*, Habana, 1911.

wavy chains, visible without lens on a moist cross section. The rays are faintly visible on cross section, invisible on tangential, fine and inconspicuous in the radial; ripple marks are absent, though sometimes a tendency to their formation is noted. *Material:* Yale Nos. 894, 3984, 4387 (Arg.); 4677 (Braz.).

A wood specimen labeled "paratodo" (Yale No. 4754) from southwestern Brazil has a structure closely resembling the "caroba" of Argentina except that it has fairly well-defined ripple marks and is somewhat darker. It may belong to the "roble" group (*Tecoma* or *Tabebuia*). The name "capoeira" is sometimes applied to *Jacaranda* sp. in São Paulo, and certain woods (Yale Nos. 3381, 3494, 3532, 4284) called "taipoca" in Bahia may belong here. Various species in Colombia are known as "caco," "caballitos," "gualanday," and "pavito." These trees yield a substance containing an alkaloid, "carobina," and a balsamic resin, "carobona," which are locally esteemed for the treatment of syphilis, cancer, and many other diseases.

One of the best known species is *J. Copaia* (Aubl.) D. Don, of the Brazilian Amazon and the Guianas. Huber[242] says: "The wood of 'caroba do matto' or 'parapará' (*Jacaranda Copaia* D. Don), a tall tree of the upland forest with bipinnate leaves and very showy red flowers, is white and light and often confused with 'marupá' (*Simaruba amara* Aubl.). It is worth while to note that the genus *Jacaranda* has nothing to do with the wood called 'jacarandá' ('palissandre' of the French) which is derived from species of *Dalbergia* and *Machaerium*." This tree is known as "fotui" or "phootee" in British Guiana and is most abundant in the Essequibo district, below the falls, where an average of 17 trees per acre has been noted. The lumber, which has some of the properties of white pine, is suited for light interior construction, boxes, crating, etc.

THE WOOD

Jacaranda Copaia (Aubl.) D. Don *Fotui.*

Common names: Fotui, futi, phootee (B. G.); bois à pian, copaïa, coupaïa des chantiers, faux simarouba (Fr. G.); jassie noedol (Sur.); copaïa (Galibis); caroba do matto, parapará (Braz.).

General properties: Color oatmeal to dingy white; luster somewhat satiny. Little contrast between heart and sapwood.

Odor and taste absent or not distinctive.

Light and soft, but firm. Sp. gr. (air-dry) 0.40 to 0.47. Weight 25 to 27 lbs. per cu. ft. Grain straight. Texture medium, uniform. Wood very easy to cut, saws woolly when green, finishes smoothly, holds nails well, is not resistant to insects or decay.

242 Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi,* 6:202 (1909).

Growth rings: Present; more distinct without lens than with it; due to slightly darker and more compact zones.

Parenchyma: Not distinct without lens; in narrow wings from pores and often confluent into tangential lines of variable length.

Pores: Readily visible, resembling small pinholes; rather few; evenly distributed; mostly single, but sometimes subdivided; open.

Vessel lines: Rather coarse and distinct, appearing darker than background and resembling resin ducts.

Vessel contents: None observed.

Rays: Very fine; at limit of vision on cross section, visible on tangential, low and uniform, but very distinct, on radial surface, where they appear considerably darker than background.

Ripple marks: Absent; local tendencies noted.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations. Rays homogeneous, with occasional tendency to heterogeneous; one or two cells wide and few to 20 cells high; cells thin-walled, rather coarse, often gummy; pits into vessels small and half-bordered. Wood fibers in radial rows; thin-walled, becoming somewhat thicker-walled at margins of growth rings; abundantly pitted throughout with slit-like pits.

Material: Yale Nos. 4215, 5083, 5083A, 5084 (B. G.). Specimen No. 5083 supplied by Forestry Officer Hohenkerk of B. G., with botanical material (B. G. No. 407A and E12) identified by Dr. S. F. Blake.

TABEBUIA AND TECOMA

These two genera are very closely allied and authorities differ as to the basis for their separation. This has resulted in the transfer of species from one genus to another until in many instances the names have become practically interchangeable. All of the species have opposite leaves and these are simple, pinnate, or digitate. The woods exhibit a wide range of variation, but these variations are specific rather than generic.

For purposes of classification, the woods are fairly readily separable into four groups typified by the following: (1) "Prima vera," (2) "roble," (3) "ipé peroba," and (4) "lapacho" or "páo d'arco." In the first the wood is uniformly creamy-white and rather light and soft; in the second it is brown with a figure on the tangential surface somewhat resembling that of plain-sawn oak, and varies from moderately hard to rather soft; in the third it is of a fairly uniform brown color with a reddish or reddish-yellow tinge, and is hard and heavy; in the fourth the wood is extremely hard and heavy, has an oily olive-brown color, and the vessels are more or less completely filled with yellow crystalline substance (lapachol), which may give the surface the appearance of having

been dusted over with sulphur. Ripple marks are always present and usually regular in "roble" and "lapacho," are usually present but very irregular in "prima vera," and usually absent in the "ipé peroba."

"PRIMA VERA"

The wood known in the American market as "prima vera" or white mahogany is apparently derived from a single species, *Tabebuia Donnell-Smithii* Rose, of Mexico and Guatemala. It is a tree from 50 to 75 feet high, with long smooth trunks often four feet in diameter. It is considered one of the most beautiful trees in Mexico on account of the profusion of its yellow flowers which appear before the leaves, "standing out against the sky like golden clouds."[243]

The exact date when this timber entered the market is unknown, but Dr. Rose (*loc. cit.*) wrote in 1892: "The trees are cut into logs about 12 feet in length, and shipped from Manzanillo in the state of Colima to the United States, principally to Cincinnati and San Francisco where they are used a great deal for cabinetwork and veneering." It has never figured largely in the New York trade. The total annual imports into the United States do not exceed 300,000 board feet.

The wood has good cabinet qualities and finishes to resemble East Indian or Ceylon satinwood (*Chloroxylon*). The timber can be had in large sizes and is usually free from defects; its principal use is for furniture, largely in the form of veneer. During the war it was used to a limited extent for airplane propellers.

THE WOOD

Tabebuia Donnell-Smithii Rose *Prima Vera.*

Common names: Prima vera, prima vera mahogany, white mahogany (Trade); prima vera, roble (Mex.); cortez, cortez blanco (Salv.); San Juan (Hond.).

General properties: Color pale yellow or nearly white to light yellowish-brown. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Rather light in weight, but firm. Sp. gr. (air-dry) 0.45. Weight about 28 lbs. per cu. ft. Grain fairly straight to roey. Texture medium to rather coarse. Wood fairly strong, easy to work, finishes smoothly, does not warp or check badly, does not appear durable.

Growth rings: Fairly distinct, due mostly to differences in density, but often accompanied by a fine line of terminal parenchyma.

Parenchyma: Inconspicuously about pores, sometimes uniting neighboring

[243] Rose, J. N.: A new *Tabebuia* from Mexico and Central America, *Bot. Gaz.*, 17: 12: 418-419, Dec., 1892.

pores into groups or short lines; also in fine line at limit of growth rings; not distinct on longitudinal surfaces.

Pores: Small to minute; mostly open; visible, but not very distinct without lens; more or less clustered and often in short irregular diagonal or tangential chains.

Vessel lines: Very numerous; fine, but distinct; finely wavy; alternately long and short on radial surface, showing ribbon grain.

Vessel contents: Tyloses present in more or less abundance, but vessels often appear open. Gum deposits not observed, although the vessels usually appear rather waxy.

Rays: Fine, but distinct, on cross section; indistinct on tangential; readily visible, but not conspicuous, on radial, when they have about the same color as the background.

Ripple marks: Usually present, though often very irregular; barely visible; about 100 per inch.

Gum ducts: None observed.

Material: Yale Nos. 4113, 4114 (C. A.); 6636 (Hond.); 7006 (Mex.).

"ROBLE"

"Roble," a Spanish name for oak, is applied to a number of different trees, but to none more commonly than to *Tecoma pentaphylla* Juss. (= *Tabebuia pentaphylla* Hemsl.), the wood of which has a superficial resemblance to oak, though it does not have prominent rays. It is doubtful if this species produces all of the wood of this type, though its range is extensive. It has generally been credited with producing one of the West Indian boxwoods of commerce, but this is a mistake.[244]

In Porto Rico "roble" or "roble blanco" is a tree from 20 to 60 feet high, of general occurrence throughout the island and said to be most common in the limestone hills. The wood is used for ox-yokes, house construction, boatbuilding, and piling. In Cuba, the "roble blanco" grows best on moist, but not stagnantly wet, soils in association with the "júcaro" (*Terminalia*), where it attains a height of 70 to 80 feet and a diameter of 24 to 30 inches, more commonly 14 to 20 inches. The trees are of good timber form, with clear lengths of 30 to 40 feet. The timber is used for ox-yokes, carpentry, interior finish, and sheathing.

In Venezuela this species, generally called "apamate," is a tree of the coastal forests and reaches a height of 80 or 90 feet, with a smooth-barked symmetrical bole often clear of limbs for 50 feet. The tree is deciduous and bears great masses of rose-colored flowers before the new leaves appear, giving it value for ornamental planting. The fruits are catalpa-like pods which later carpet the ground with their winged seeds. The timber is common in all the local sawmills and carpenter shops,

[244] Record, S. J.: Boxwoods of commerce, *Bul. Tor. Bot. Club*, 48: 298-299.

and provides the native lumber most commonly used for rough structural purposes. It is also employed for flooring and interior finish. It is not very durable in contact with the ground and is liable to attack by insects.

Regarding the "roble" in Colombia, Mr. Curran says: "Scattered individuals were met with in the forests of Magdalena and it is a common second-growth tree about towns and along the waterways. As a rule it is short-boled, 18 to 20 inches in diameter, with heights under 75 feet and clear lengths not over 20 feet. It seemed to be well known and appreciated by the local carpenters for furniture and interior finish."

Tecoma pentaphylla is a savanna-tree, following the open plains along the Pacific coast from Panama to Guerrero, Mexico, and probably farther. Little information is available regarding its occurrence on the Atlantic slope. Dr. Whitford collected it along the eastern part of the Guatemala-Honduras boundary, where it averages about 70 feet high, with a clear bole of 40 feet and 20 inches in diameter, and supplies lumber for house construction. In Panama it is used locally in the construction of piers, boats, carts, and in joinery. Some logs have been imported from central Mexico into western United States and sawn into flooring.

Specimens of wood (Yale Nos. 3404, 3414, 4688) from Bahia, Brazil, belong to this group and the rather fragmentary herbarium material accompanying one of them resembles *T. pentaphylla*. The tree reaches rather large dimensions and the lumber is used for general construction. It is known locally as "taipoca," a name variously spelled and apparently applied to several other woods.

From some of the published descriptions, it would seem that the white cedar or "warakuri" ("waracoori," "warikuri") of British Guiana belongs in this group, but no wood specimens are available for study. It grows plentifully in swampy places, with a height of 50 to 70 feet and diameter of 12 to 24 inches. It owes its English name to the resemblance of the bark to that of the Spanish cedar (*Cedrela*). Various statements regarding its properties are conflicting and indicate a confusion of species.

THE WOOD

Tecoma pentaphylla Juss. *Roble.*

Common names: Roble (Sp. Am., gen.); roble blanco (P. R.); palo blanco, roble blanco, roble de yugo (Cuba); apamáte, roble colorado (Venez.); ocobo (Col.); roble de savana (Pan.); mano de león, matilisquate (Guat.-Hond.); maculigua, macuiliz, maquiligua (Salv.); cortes, macuelizo (Hond.); amape, macuil, maculiz, maculiz prieto, mano de león, maría blanca, palo

yugo, roble blanco, palo de rosa (Mex.); poirier, poirier du pays (Mart.); white cedar, warakuri (B. G.); taipoca (Braz.).

General properties: Color a rather dull grayish-brown with fine striping of deep brown, often in conspicuous pattern on tangential surface. Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Moderately light and soft to rather hard and heavy. Sp. gr. (air-dry) 0.62. Weight about 39 lbs. per cu. ft. Grain usually straight; sometimes roey or wavy. Texture medium, wood easy to work, finishes smoothly, seasons without difficulty, looks fairly durable.

Growth rings: Present; fairly distinct; due to slight differences in density and also to more orderly arrangement of the elements.

Parenchyma: In irregular tangential or concentric bands containing the pores; occasionally in lines independent of the pores and also limiting growth rings; very distinct on longitudinal sections, being considerably darker than background.

Pores: Small to rather large; visible; open; rather numerous; occurring singly or in small groups; mostly, but not always, joined by parenchyma into ulmiform bands, very irregular in inner portion of rings and tending to become fairly regular and concentric in outer portion of wide rings.

Vessel lines: Very distinct because of parenchyma layers, producing distinct pattern on tangential surface.

Vessel contents: None observed.

Rays: Very fine; faintly visible on cross and tangential sections; fine and inconspicuous on radial surface.

Ripple marks: Present; fairly regular; all elements storied; visible without lens; 80-95 per inch.

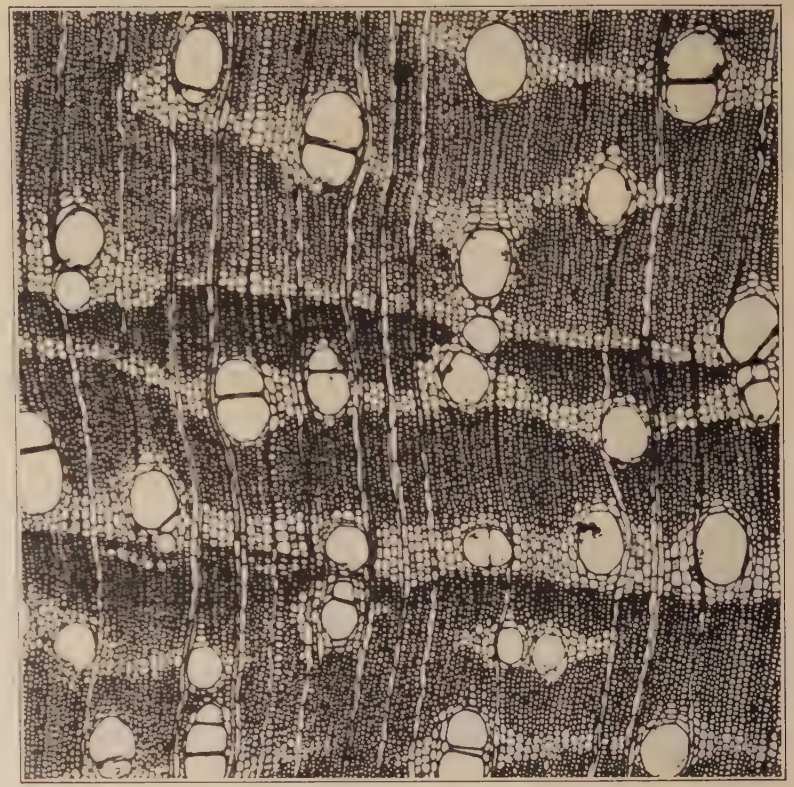
Gum ducts: None observed.

Remarks: The pores in the Brazilian specimens of "taipoca" are smaller, much more numerous, and much more like elm (*Ulmus*) than in the others of this group.

Material: Yale Nos. 58, 97 (Hond.); 3670* (Guat.-Hond.); 2955*, 7133* (Pan.); 467, 506, 1538*, 4440 (Col.); 351, 356, 467, 2681, 4417 (Venez.); 3403, 3414, 4688* (Braz.); 2698, 4625 (P. R.); 4402*, 4758* (Mex.); 5010 (Cuba). Asterisk indicates botanical material.

"IPÉ PEROBA"

In this group is included the common "peroba" of Rio de Janeiro, Minas Geraes, Espirito Santo, and Bahia as contrasted with the "perobas" of São Paulo, which are species of *Aspidosperma* (Apocynaceae). Its identity, which has long been in doubt, is determined from specimens of the wood (Yale No. 3257), leaves, and fruit collected by Dr. Whitford in the forest of Espirito Santo under the name of "peroba amarella." The tree was about 130 feet high with a slender symmetrical trunk about 95 feet long and 30 inches in diameter, covered with a



Cross Section of Roble Wood (x 50).
(*Tecoma pentaphylla.*)

Photo by H. M. Curran.

The Lapacho of Argentina.
(*Tecoma sp.*)

PLATE L

distinctly ridged, yellowish bark. The leaves are digitate, coriaceous, opposite, glabrous; petioles two to two and a half inches long, deeply grooved above, rounded and finely ridged beneath; leaflets three to seven, mostly five, the grooved petiolules 0.5 to 1.2 inches long (the lateral ones shortest), the serrate blades ovate-lanceolate, long-pointed, rounded or broadly wedge-shaped at the base, the largest about four inches long and 1.25 inches wide; veins prominent beneath. Flowers not known. Capsule woody, thick-walled, linear, flattened, pointed, two-ribbed, about 12 inches long, 0.75 inch wide, 0.3 inch thick, the surface glabrous and finely granular; loculicidally dehiscent. Seeds numerous, flat, with membranaceous entire wings; total length about two inches, width about 0.40 inch, the cotyledons 0.75 inch long and 0.30 inch wide; in double rows on flattened coriaceous placenta with small ridge at each end. The specific name, if one has been given to it, is unknown and it is here referred to as *Tecoma Peroba.*

This is one of the most important woods in the market of Rio de Janeiro. Nearly all of the better class of houses, banks, and stores are finished with it and much of the best quality of furniture is of this wood. It has recently entered the New York market in limited amounts and a cabinetmaker there says of it: "'Peroba' wood is a yellowish, moderately hard wood obtained in large logs sometimes 30 inches through. It takes stain fairly well, is of about the color of greenheart, and has a texture suggesting Santo Domingo satinwood. If not properly dried, it is likely to check when exposed to warm temperature. Experienced workmen are careful to avoid the splinters which they believe to be poisonous."

THE WOOD

Tecoma Peroba Record *Ipé Peroba.*

Common names: Peroba, ipé peroba, peroba amarella, peroba branca, peroba reseca, peroba verdadeira, peroba do campo (Rio to Bahia, Brazil).

General properties: Light olive-brown with a yellowish, greenish, or reddish hue; fairly lustrous. Sapwood grayish or pale yellowish; sharply defined. Odor and taste absent or not distinctive.

Rather hard and heavy. Sp. gr. (air-dry) 0.70 to 0.83. Weight 43 to 52 lbs. per cu. ft. Grain fairly straight to finely roey; sometimes beautifully figured. Texture medium. Wood fairly easy to work, takes a smooth finish, is tough and strong; appears durable.

Growth rings: Present; fairly distinct on all sections; due to some differences in color and in density; also to fine line of parenchyma, which often is not continuous.

Parenchyma: Associated with pores, but not distinct; sometimes also visible with lens, in very fine lines, terminating growth rings.

Pores: Small, but visible; numerous to very numerous; occurring singly or more often in short radial groups and with tendency to formation of diagonal and wavy lines; closed.

Vessel lines: Rather fine and inconspicuous.

Vessel contents: Tyloses abundant; yellow substance (lapachol) sparingly present.

Rays: Very fine, but visible on cross section; invisible on tangential; visible, but inconspicuous, on radial, being of the same color as background.

Ripple marks: Present, but irregular; barely visible without lens and not very distinct with it; all elements in seriation. Number per inch 90 to 95.

Gum ducts: None observed.

Remarks: This wood has a structure resembling "prima vera" but is more compact, finer-textured, and darker-colored; it should not be confused with "peroba rosa."

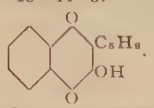
A specimen (Yale No. 5253) of "moah" wood or "edelteak," of unknown origin, supplied by Professor Matthes, apparently belongs in this group, since it has the structure and general appearance of "ipé peroba," and some of the vessels contain small amounts of lapachol. The wood is said to be poisonous to workmen.[245]

Material: Yale Nos. 677, 695, 702, 703, 717, 3101, 3189, 3257, 3304, 3306, 3537 (Braz.).

"LAPACHO" OR "PÁO D'ARCO" GROUP

This group includes many species of *Tecoma* (or *Tabebuia*), which are widely distributed throughout tropical America. They are valuable timber trees, yielding woods which are extremely hard, heavy, strong, and durable, of a brown or reddish-brown color, and having an oily appearance. Some or all of the vessels are filled with a yellowish powder (lapachol[246]) which often covers the surface with a sulphur-like dust which, when moistened with ammonia or dilute sodium carbonate, turns a deep wine-red, thus providing a reliable diagnostic feature. The woods are further characterized by having their elements storied, the number of ripple marks per inch varying from 90 to 120.

[245] See Matthes, Hermann and Emil. Schreiber: Ueber hautreizender hölzer, *Ber. d. deutschen Pharm. Gesellschaft.*, Berlin, 1914, S. 19-22.

[246] Lapachol ($C_{15}H_{14}O_3$) is an amylene derivative of β-hydroxy-*a*-napthaquinone of the formula 

. It crystallizes in golden-yellow leaflets, melts at about 139° C., and forms intensely colored salts which have given some of the woods containing lapachol a local value for dyeing purposes. Its occurrence appears to be limited to certain woods of this family and the heartwood of *Avicennia* (Verbenaceae). It has been made the subject of exhaustive research by Dr. Samuel C. Hooker, 82 Remsen Street, Brooklyn, N. Y.

Argentina. "Lapacho" is one of the most valuable timbers of this region. The principal commercial operations are along the Paraná River in Misiones and across the river in Paraguay. The tree is one of the tallest in the Misiones forest, reaching a height of 100 to 125 feet, with a cylindrical though slightly buttressed bole, free of limbs for 60 to 70 feet, and often three or four and sometimes six feet in diameter. The digitate leaves are six to eight inches in diameter and are deciduous. The flowers, usually of a rose color, are borne in profusion just before the new leaves appear, making the trees a resplendent feature of the landscape. The trees occur gregariously on steep rocky hillsides and are also found in smaller numbers through the lowland forests. The timber reaches the market in the form of square-hewn logs, and between four and five million board feet are used annually for general construction, carpentry, cabinetwork, turnery, and vehicles. It is considered one of the best woods for wagon spokes. It is highly resistant to decay and consequently is used for many purposes requiring a strong and durable material. It also yields a purplish dye. (Plate L.)

Brazil. This group is well represented in Brazil, where there are numerous species, some of them small or medium-sized trees, others of large dimensions. The common name in the South is "ipé," with many varieties recognized, while in the North it is "páo d'arco," a name applied to other woods as well. According to Pereira,[247] all of the varieties are used for carts, barrels, casks, bridges, posts, and general construction, particularly in exposed situations. "Ipé tobaco" makes a railway tie of first quality, lasting 11 years, while "ipé una" is rated second-class and lasts only nine years. All of the kinds have astringent bark considered of medicinal value in the treatment of syphilis, and the bast of "ipé tobaco" is used for cigarette papers.

Huber[248] says: "The 'páo d'arco amarello' is one of the tallest trees in the uplands of the Amazon region. At the close of the dry season it loses its leaves and covers itself with an infinite number of large yellow flowers of golden hue, giving to the crowns the appearance of enormous bouquets in the midst of the forest. The 'páo d'arco rôxo' is taller still and, along the Capim River for example, holds its obconic crown well above all the other trees in the upland forest. Its flowers are violet and not as showy as those of the 'páo d'arco amarello.' There is much confusion regarding the botanical classification of these two species. Both certainly belong to the genus *Tecoma*, but it is very likely that the 'páo d'arco amarello,' at least, does not correspond to a single botanical

247 Pereira, Huascar: *The timber trees of the state of São Paulo, Brazil*, p. 52.
248 Huber, J.: Mattas e madeiras amazonicas, *Bol. Mus. Goeldi*, 6:201-202 (1909).

species, but to several which have not as yet been sufficiently investigated. The 'páo d'arco rôxo' is probably a species new to science. There is generally no distinction made between the woods of two kinds, presumably because the distinguishing features are not sufficiently pronounced. That of 'páo d'arco' is very hard and heavy, straight-grained, the color light gray [parda clara] to dark gray [parda escura]. When freshly sawn, the vessels appear to be full of a yellow-greenish powder that is irritating when inhaled; whence the name 'ipé tobaco' in the South. In French Guiana a species of *Tecoma* is called 'ebène vert.' The 'páo d'arco' has a wood that is well suited for general construction as well as for the manufacture of furniture and articles of turnery. Its name is derived from the Indians' use of the wood for their bows."

There are at least two species called "páo d'arco" in Bahia, and herbarium material of them collected by Mr. Curran has been identified (Yale No. 4672) as *Tecoma chrysotricha* Mart., and (Yale No. 4686) as *T. alliacea* Cham.

The Guianas. In British Guiana the best known trees of this group are the "washiba" or bow-wood and the "hackia." There are several kinds of "hackia," distinguished mostly by the leaves, which may be either three- or five-digitate, glabrous or tomentose, the leaflets entire or serrate. The commonest kind has five-digitate leaves with entire leaflets and yellow flowers. It grows chiefly on the sandy hills and soils not very favorable for its development. The "washiba" is similar, but occupies the flat clay lands along streams and consequently is of larger size and better timber form. It is said to attain a height of 120 feet or more with trunks large enough to square 30 inches free of sap. The wood is strong, very elastic, and highly durable.

A closely related species in Surinam is the "groenhart" which yields the so-called Surinam greenheart or bethabara of commerce, widely known because of its use in the manufacture of fishing rods. The tree grows also in French Guiana and probably in British Guiana. Its botanical status, as in most of the others of this group, is in doubt, though on the authority of Dr. A. Pulle of Utrecht it has been referred to *Tecoma leucoxylon* Mart. Janssonius,[249] who gives an excellent detailed description of this wood, uses the name *Tecoma leucoxylon* Mart. var. *pentaphylla*. The tree is said to grow to large size and many of the logs exported are from 20 to 40 feet long and about 24 inches square, free of sap, while larger sizes could be obtained if adequate means were available for transporting them out of the forest. The wood is sometimes con-

[249] Jannssonius, H. H.: Mikrographie einiger technisch wichtigen holzarten aus Surinam, *Verh. d. k. Akad. v. Wetenschaffen te Amsterdam*, 18: 2: 41-46, Feb., 1914.

fused with the Demerara greenheart (*Nectandra Rodioei* Schomb.) from which it is readily distinguishable by the ripple marks as well as by the yellow substance[250] in the pores of the Surinam species. It is not considered a good substitute for Demerara greenheart in places exposed to the action of teredo.

Venezuela. There are various species of this group in Venezuela which yield fine-textured, hard, heavy, and durable timbers valued for general construction, railway ties, and fence posts. One of them, the "curarire," is exported in considerable amount from the port of Maracaibo. The specimen available (Yale No. 357) is very dark brown with black streaks and contains less lapachol and has less parenchyma than the others. The "flor amarillo," so called on account of its conspicuous yellow flowers, is said to be *Tecoma spectabilis* Pl. & L. It is a tree 50 to 75 feet high, usually with rather short trunks 12 to 18 inches in diameter, the wood of which is extremely hard, of an oily dark brown color, sometimes with streaks of black. The "araguaney," believed to be *T. chrysantha* DC., and the "acapro," an unknown species, are larger trees reaching a height of 80 to 100 feet and diameters of 16 to 24 inches. The woods are difficult to work because of their density, but are highly durable and very strong. The "pui" or "poui," *T. serratifolia* G. Don, is one of the best known timbers of Trinidad where it is much used for fence posts and durable construction. It also grows on the mainland, where it is known by the same name and sometimes also as "echa-humo," and is employed for cabinetwork and turnery as well as for heavy construction. (Plate III.)

Colombia. The most common Colombian species is *Tecoma spectabilis* Pl. & L., known as "chicalá" in Anapoima, "cañaguate" in Magdalena and Santander, and "guayacan polvillo" in Antioquia, according to Cortés.[251] Mr. Curran says: "The 'guayacan polvillo' reaches a height of 100 feet or more, with clear lengths of 40 to 50 feet and diameters up to three feet. It is practically the same tree as the 'lapacho' of Argentina and the 'ipé' of Brazil. Judging from my own experience it is a rather rare tree in the river forests, averaging less than two trees per acre at best. The lumber is found in small quantities in the market and is used for heavy and durable construction."

Central America and Mexico. The group is well represented in this region and some of the timber has been exported to the United States

250 This lapachol compound is given off as a fine dust in working the wood and when the workmen use alkaline soap in washing it off, the yellow quickly changes to a pronounced salmon color.

251 Cortés, Santiago: *Flora de Colombia,* Bogota, 1897, p. 98.

as yellow guayacan or lignum-vitae. The tree is known by the natives as "guayacan," and as this name is also commonly applied to the true lignum-vitae (*Guaiacum*), the two woods have been confused in the market and various attempts were made during the war to substitute the *Tecoma* timber for that of *Guaiacum* in the manufacture of propeller-shaft bearings in steamships. The wood has the requisite density, but lacks the oily resin which makes the genuine lignum-vitae self-lubricating.[252]

The "guayacan," *Tecoma Guayacan* Seeman, is a tree sometimes 100 feet high, with an erect trunk upward of four feet in diameter, somewhat buttressed at the base, with a nearly smooth reddish or grayish bark, and with ascendant limbs forming a rounded crown. The leaves resemble those of the horse-chestnut and buckeye (*Aesculus*) and the flowers are yellow. The known range is from eastern Panama to Michoacan, Mexico, on the low dry foothills mostly on the Pacific coast, though reaching the Atlantic watershed in the Chagres Basin of Panama and also in the Alta-Verapaz of Guatemala, where the tree is known as "cortes" or "corteza."

The wood is considered one of the best of Panama and has many uses, particularly in heavy and durable construction. The natives use the buttresses for making agricultural implements and tools and also in building boats. The cathedral of Old Panama contained beams of "guayacan" and some of these timbers are still perfectly sound although exposed to the weather since the destruction of the city 250 years ago.

The "amapá" or "amapá prieto" of Mexico is referred to *Tabebuia Palmeri* Rose. Dr. Whitford says: "On the Tres Marias islands off the west coast of Mexico, the 'amapa prieto' is a tree with a maximum diameter of 24 inches and irregular bole 20 to 30 feet in length. Its wood is dark reddish-brown, very hard, very heavy, with very fine pores; good for ties; said to be very durable in contact with the ground." The wood (Yale No. 2949) is much like the yellow guayacan, but contains a relatively small amount of lapachol in its vessels.

THE WOOD

Tecoma (or *Tabebuia*) spp. *Lapacho or Páo d'Arco Group.*

Common names: Lapacho, lapacho amarillo, lapacho blanco, lapacho crespo, lapacho negro, lapacho rosa, lapachillo, tally, taye, tayí (Arg.); tajibo (Boliv.); ipé, ipé amarello, ipé cascudo, ipé folhas rôxas, ipé jabotiá, ipé preto, ipé rôxo, ipé tobaco, ipé una, ipé do campo, ipé da varzea, páo d'arco, páo d'arco amarello, páo d'arco rôxo, quiarapaíba, urupariba (Braz.);

[252] For further information see Record, S. J.: *Lignum-vitae,* Bul. No. 6, Yale School of Forestry, New Haven, Conn., 1921, pp. 42-43.

hackia, iron-tree, ironwood, wasiba, washiba, bow-wood (B. G.); groenhart, groenhati, ijzerhout (Sur.); ebène verte, bois d'ebène verte, gupariba (Fr. G.); arahoní, arrhonée (Galibis); araguaney, acapro, curarire, echa-humo, flor amarillo (Venez.); pui, poui (Trin.); chicalá, cañaguate, guayacan polvillo (Col.); guayacan (Pan.); cortes, corteza, mano de león (Guat.); cortez amarillo, cortez negro, cortez prieto (Salv.); corteza amarilla, guayacan (C. R.); quebracho, masicarán (Hond.); amapá, amapá prieto, guayacan, roble, verdecillo (Mex.); yellow guayacan, bastard lignum-vitae, Surinam greenheart, bethabara,[253] washiba, noibwood (Trade).

General properties: Color olive-brown or reddish-brown, sometimes with darker streaks; looks rather oily; surface often covered with yellow powder. Sapwood yellowish-gray; usually sharply defined.

Odor and taste absent or not distinctive.

Very dense and hard; usually horn-like. Sp. gr. (oven-dry) 0.95 to 1.25. Weight 59 to 78 lbs. per cu. ft. Grain usually irregular; often roey; sometimes fairly straight. Texture very fine to medium. Wood hard to cut, fairly easy to split tangentially, but usually very tough radially, often splintery, takes a high polish; very durable.

Growth rings: Usually present, but not always clearly defined; due to zones deficient in pores and sometimes to fine line of terminal parenchyma.

Parenchyma: Inconspicuous; about pores and sometimes connecting them tangentially; sometimes in fine lines at limits of growth rings; variable in different woods and different parts of same specimen.

Pores: Small to minute in some woods, medium-sized in others; usually distinct on account of yellow or white contents; numerous; occurring singly or in short radial groups, or jointed tangentially by parenchyma; fairly well distributed.

Vessel lines: Mostly fine; often distinct because of contents.

Vessel contents: Few to nearly all of vessels filled with yellow powder (lapachol compound), which turns red upon application of alkali or ammonia. Some white substance sometimes present.

Rays: Very fine; not visible without lens on cross section; not individually visible on tangential; visible, but uniformly low and inconspicuous, on radial.

Ripple marks: Present; all elements storied; usually visible without lens; mostly regular; number per inch variable in different specimens from 90 to 120.

Remarks: Presence of lapachol apparently distinguishes this group from all other woods except *Avicennia* (Verbenaceae), and the latter has anomalous structure and is without ripple marks.

Material: Yale Nos. 531, 902, 914, 926, 930, 992, 1078, 1090, 1124, 1717*, 1730, 1740, 4000, 4123, 4385, 4395 (Arg.); 1480, 1485, 2503, 3155, 3242, 3260*, 4021, 4040, 4260, 4672*, 4686*, 4746 (Braz.); 4219 (B. G.); 4174, 4436, 4786 (Sur.); 2747* (Curaçao); 322, 357, 440*, 2661, 2680, 2739

[253] The name bethabara was copyrighted by Mr. Malcolm A. Shipley, formerly a manufacturer of fishing rods in Philadelphia, but the copyright was not sustained by the court before whom a case of infringement was tried.

(Venez.); 409*, 513 (Col.); 3707* (Guat.); 27, 85 (Hond.); 2949*, 4143, 4477 (Mex.). Asterisk indicates botanical material.

CRESCENTIA

This genus consists of about 15 known species of small or medium-sized trees, a few of which are cultivated for their fruit and also for purposes of ornament and shade. The black calabash, *Crescentia cucurbitina* L., reaches the shores of southern Florida, where it is 18 to 20 feet high and four to five inches in diameter. The best known species is the common calabash of the West Indies, *C. Cujete* L., a tree sometimes 50 feet high and 18 inches in diameter. The gourd-like fruits are used by the natives for making cups, dishes, and other utensils and are sometimes artistically carved. The wood is made into ox-yokes, saddles, tool handles, and vehicle parts.

THE WOOD

Crescentia Cujete L. *Calabash.*

Common names: Calabash (B. W. I.); higüero, cotumo (P. R.); güira, güira cimarróna (Cuba); calabasse (Guad.); calebassier (Fr. G.); cuieira, cabaceira, cuité, cuieté, arvore de cuia (Braz.); calabas, kalabose (Curaçao); taparo, totumo (Venez.); totuma (Col.); cujete, guiro, jicara, jicaro, morro, tecomate, tigulate, temante, palo de melón, melon tree (Mex., C. A.); guacal, jicaro (Salv.). Other species: Black calabash (Fla.); cuchara, morrito, morro (Salv.); morro (Guat.); ayal, ayale, tecomate (Mex.).

General properties: Color light brown or yellowish-brown, with fine veining of darker color, as in "roble." Sapwood not clearly defined.

Odor and taste absent or not distinctive.

Moderately hard and heavy, tough and strong. Sp. gr. (air-dry) 0.60. Weight about 37 lbs. per cu. ft. Texture coarse. Wood of the consistency of elm (*Ulmus*), fairly easy to work, takes a smooth finish; probably not durable.

Growth rings: Present; fairly well defined; due to more orderly arrangement of the elements.

Parenchyma: About pores and connecting them tangentially into wavy bands, suggesting elm (*Ulmus*); distinct on tangential surface, producing irregular dark pattern on light background.

Pores: Small; visible; fairly numerous; occurring singly or in small groups; joined tangentially by parenchyma.

Vessel lines: Fine, but distinct because of parenchyma.

Vessel contents: None observed.

Rays: Very fine; barely visible on cross section; invisible on tangential; visible, but fine and inconspicuous, on radial surface.

Ripple marks: Present; irregular and indistinct; about 120 per inch.

Gum ducts: None observed.

Remarks: Inner bark separable into many thin papery layers.

Material: Yale Nos. 2679, 2693, 4552 (P. R.); 2757*, 2777* (Curaçao). Asterisk indicates botanical material.

73. ACANTHACEAE

The Acanthus Family consists of about 180 genera and over 2000 species of herbs, shrubs, and twining vines, widely distributed in tropical and sub-tropical regions; also two tropical American genera, *Trichanthera* and *Bravaisia*, with a very few species of trees. The woods of the family are light-colored and vary from soft to moderately hard; they are little used.

BRAVAISIA

The best known species, possibly the only one, of this genus is *Bravaisia floribunda* DC., said to occur from southern Mexico through Central America into Peru, Colombia, and Trinidad. The only information available regarding the tree is supplied by Mr. Curran, who collected it in the Department of Bolivar, Colombia, under the name of "sancho-araña" which presumably refers to the spider-like root system. (Plate XLIX.)

It is a common tree in the river forests and is usually 30 to 40 feet high and a foot in diameter, rarely 75 feet high and 18 to 20 inches through. It is short-boled, and covered with a thin gray or black bark. The stilt-like roots form a great mass about the base of a tree or a clump and suggest mangrove except that they do not extend down from the branches. The leaves are rather large, membranous, simple, and opposite on the angular stems. The flowers are white and borne in large terminal panicles; the fruits are dehiscent capsules about half an inch long. The wood is used to a limited extent for charcoal and is suitable for paper pulp and box boards.

THE WOOD

Bravaisia floribunda DC. *Sancho-araña.*

Common names: Sancho-araña (Col.); naranjillo bobo (Venez.).

General properties: Color whitish or grayish; likely to sap-stain. No distinction between heart and sapwood.

Odor and taste absent or not distinctive.

Rather light and soft but firm. Sp. gr. (air-dry) 0.53. Weight 33 lbs. per cu. ft. Grain straight. Texture medium. Wood very easy to work, finishes smoothly, is tough and strong for its weight, but is perishable when exposed to decay.

Growth rings: Absent or very poorly defined.

Parenchyma: Scantily developed; in narrow layer about pores; not distinct with lens.

Pores: Small; barely visible; fairly numerous, but not crowded; rounded; uniformly distributed; occurring singly or subdivided radially; open.

Vessel lines: Fine and indistinct.

Vessel contents: None observed.

Rays: Distinct on cross section; faintly visible on tangential; rather conspicuous on radial surface, where they appear darker or lighter than background, depending upon the lighting.

Ripple marks: Absent.

Gum ducts: None observed.

Minute Anatomy: Vessels with simple perforations; pits between vessels mostly very small with slit-like, often coalescing, apertures, but sometimes rather large and elliptical or tending to scalariform. Rays decidedly heterogeneous; one to five cells broad, and few to 40 cells high; pits into vessels simple or half-bordered, much elongated and often in scalariform arrangement. Parenchyma paratracheal; yellow contents common. Fibers in fairly regular radial rows; thin-walled; septate; pits very small, lenticular, scattered irregularly. Pith large, coarsely chambered.

Material: Yale Nos. 1534 and 3964 collected by Mr. Curran in Colombia with botanical material; his Nos. 317 and 308 respectively.

74. RUBIACEAE

The Madder Family consists of about 350 genera and 6000 species of trees, shrubs, and herbaceous plants, mostly tropical. Some of the best known representatives are *Cinchona*, the source of cinchona bark and quinine, the coffee tree, *Coffea arabica* L., cultivated so extensively in tropical countries, the madder, *Rubia cordifolia* L., the important dye-yielding plant of the Himalayas, and the common decorative plant, *Gardenia*. There are about 60 arborescent genera in tropical America, but the trees are mostly small and of little value. Only *Calycophyllum* and *Genipa* supply timbers of commercial importance, although some of the others may prove of value as substitutes for boxwood and lancewood since they are fine-textured, mostly hard and heavy, and usually light-colored.

CINCHONA

There are many closely related species of *Cinchona* and their natural habitat is in the Andes. The efficacy of the bark as a febrifuge was known to the Indians, who imparted the information to the Spanish settlers and Jesuit missionaries. The fourth Count of Chinchon is credited with introducing the bark into Europe upon his return to Spain about 1640 from his post of viceroy of Peru. Parcels of the powdered bark were subsequently sent to Rome by missionaries and distributed by one of the cardinals, giving rise to the name Jesuits' bark or cardinal bark. The aboriginal name of the tree was "quina-quina."

Although cinchona bark is still an article of export of South America, the great bulk of that commodity and of sulphate of quinine now comes from British plantations in India, Ceylon, and Jamaica, and Dutch plantations in Java. During the fiscal year ending June 30, 1914, the United States imported nearly 3,000,000 ounces of sulphate of quinine, valued at about $650,000 and over 3,648,000 pounds of cinchona bark, valued at $464,000.

CALYCOPHYLLUM

This genus consists of three or four species widely distributed throughout tropical America and highly valued for their timber. The "palo blanco" of Argentina, *Calycophyllum multiflorum* Gris., is abundant in the forests of Formosa, Jujúy, and Salta, and is considered one of the most beautiful trees of that region. It is usually about 65 or 70 feet high and from 20 to 30 inches in diameter. The wood is of about the consistency of sugar maple (*Acer saccharum* Marsh.) and is used for vehicles, implements, cogs of wheels, shoe lasts, turnery, and for all sorts of purposes requiring a strong, fine-textured wood. The best grades of it are suitable for many of the uses of boxwood; apparently it would make excellent hardwood floors, fishing rods, and weaver's shuttles.

The "páo mulatto," *C. Spruceanum* Benth., is one of the most frequent trees throughout the Amazon region and is also common in southern Brazil. It grows gregariously, is often 90 to 100 feet high, with clear lengths of 30 to 40 feet and diameters of 24 to 36 inches. The branches have such narrow forks that the crown is usually in the form of an inverted cone. The reddish-brown bark is continually peeling off and being renewed, which accounts for the name "páo mulatto." The flowers are conspicuous and resemble those of the hawthorn (*Crataegus*) in color and fragrance. The timber is employed in turnery, and also for general construction, furniture, tool handles, and vehicles. It makes excellent fuel and, because of its abundance along the waterways, is much used for this purpose on steamboats and launches.

The degame of commerce is supplied by *C. candidissimum* (Vahl) DC., which extends from Cuba along the hills of the northern coasts of South America through Central America into southern Mexico. It is a medium-sized tree, 40 to 65 feet high and from eight to 18 inches in diameter. The trunk is usually straight, free of limbs, mostly cylindrical, but sometimes more or less furrowed, and covered with a reddish-gray shaggy bark. The timber has been exported from Cuba for a long time, usually in the form of small round logs or "spars," commonly called

degame spars in the trade. It is used as a substitute for the true lancewood (*Oxandra*) and is sometimes called degame lancewood. It has the strength, toughness, and resilience of hickory and is used for the shafts, spokes and rims of vehicles, agricultural implements, tool handles, canes, fishing rods, various articles of turnery, and also for construction, cabinetwork, and carpentry.

THE WOOD

Calycophyllum candidissimum (Vahl) DC. *Degame.*

Common names: Degame, degame lancewood, degame spars (Trade); dágame (Cuba); sálamo, madroño (C. A., gen.); espino madroño (Nic.); alazano, guayabo alazano (Pan.); camarón, palo camarón (Mex.). Other species: Páo mulatto (Braz., Peru); corusi-caá (Ec.); palo blanco, ibirá moroti, morotobi (Arg.); sunleaf, mulatto tree (Eng.).

General properties: Color variegated brown, rather dull. Thick sapwood nearly colorless to brownish-white. Commercial wood is mostly sapwood.

Odor and taste absent or not distinctive.

Hard, heavy, and compact. Sp. gr. (air-dry) 0.80. Weight about 50 lbs. per cu. ft. Grain straight to irregular. Texture fine and uniform. Wood strong and resilient; fairly easy to carve; does not split easily; takes a high polish; does not appear durable.

Growth rings: Present, but not very distinct; due to slight difference in abundance and arrangement of pores and fibers; sometimes also to light-colored lines.

Parenchyma: Not distinguishable.

Pores: Extremely small; not visible without lens; very numerous and well distributed; occurring singly or more often in radial groups of two to several.

Vessel lines: Scarcely visible.

Vessel contents: None observed.

Rays: Invisible or nearly so on cross section; invisible on tangential section and not distinct with lens; readily visible, but inconspicuous, on radial surface, being low and only slightly darker than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; inter-vascular pits rather small and very abundant. Rays decidedly heterogeneous; one to four cells wide and few to 30 cells high; pits into vessels half-bordered, often in reticulate arrangement. Wood fibers in radial rows; bordered pits few and inconspicuous. Parenchyma very sparingly developed.

Remarks: The absence of concentric lines of wood parenchyma readily distinguishes this wood from the true lancewood (*Oxandra*). The woods of the different species of *Calycophyllum* are very much alike; there is some difference in density, the Brazilian specimens being the heaviest.

Material: Yale Nos. 784, 4787, 4997 (Cuba). Other species: 2992 (Pan.); 1125, 3975, 4129, 4136, 4386 (Arg.); 4747 (Braz.); 4386 (Parag.).

GENIPA

Most of the 20 or more described species of this important genus are natives of Madagascar. The two best known in tropical America are *Genipa americana* L. and *G. Caruto* H. B. K. The principal distinction is that the under side of the leaves is densely pubescent in the one and glabrous in the other, but inasmuch as all possible transitions in the leaf characters are observable and the ranges of the two trees are the same, some botanists consider them as extreme forms of a single species. The woods are indistinguishable.

In the West Indies the tree, usually called "jagua," is very common in the lowlands. It is rarely 70 feet tall with a trunk from 24 to 40 feet long and 24 inches in diameter; the usual commercial diameters are 15 to 18 inches. The wood has many of the properties of ash (*Fraxinus*) and is extensively used for boxes, chests, barrel hoops, sieve rims, shoe lasts, gunstocks, and in vehicle manufacture.

According to Mr. Curran, the tree occurs sparingly in the virgin forest of eastern Brazil, rarely averaging more than one per acre, but is abundant in and about towns and villages, since it is planted as a shade tree or comes up spontaneously and is protected because of its fruit. It is usually rather short-boled, a clear length of 50 feet being the maximum, and the diameter ranging up to three feet. The leaves are broad and leathery, and the flowers are large, yellowish-white, opening all at a time. The fruit, which is about two inches in diameter, has a leathery shell inclosing an astringent pulpy interior that is relished by the inhabitants; when immature it yields upon maceration a blue-black color that is extensively employed for domestic dyeing. The lumber is well known and is suitable for a great many purposes, particularly for bent work, but the wood usually contains so much moisture that it is rather difficult to season properly without the use of dry-kilns. It should prove a satisfactory substitute for ash.

In Panama this tree is rarely over 50 feet high and 14 inches in diameter, sometimes with a crooked trunk. It does not grow gregariously and is found usually near the savannas or in open woodlands. The dye from the fruit is used by the Indians for tattooing and painting their bodies, particularly in preparation for ceremonial rites. The pulp of the ripe fruit is relished, as is also a wine made from a combination of it and other fruits. The wood is used for construction, and is always preferred for the side of the door and door casing bearing the hinges.

THE WOOD

Genipa americana L. *Jagua; Genipa.*

Common names: Jagua (Span., gen.); genipa, genipat, genipayer, genipo,

bois de fer, lana (Fr. W. I.); caruto (Venez., trin.); genipapa, genipapo, genipapeiro, genipapo do matto, junipapo (Braz.); irayol (Salv., Guat.); jagua azul, jagua blanca, maluco (Mex.); ñandipá (Arg., Par.); hagua, jagua, xagua, janipha, junipa (Misc.).

General properties: Color dull brownish-gray, sometimes with a pinkish or yellowish hue; some specimens show deeply colored blue stain just beneath the surface. Sapwood not distinct.

Odor and taste absent or not distinctive.

Hard and heavy. Sp. gr. (air-dry) 0.73 to 0.84. Weight 45 to 52 lbs. per cu. ft. Grain fairly straight to irregular. Texture rather fine. Wood strong and tough, elastic; works without difficulty; is rather harsh; finishes smoothly, but without high luster.

Growth rings: Absent or indistinct; when present, due to narrow zones in which the pores are less abundant.

Parenchyma: Not visible without lens and indistinct with it. Mostly diffuse or in very short lines at right angles to the rays.

Pores: Small to very small, but usually visible without lens; fairly uniform in size in given material, though in certain specimens they are considerably more distinct than in others. Very abundant, well distributed; mostly single, but sometimes subdivided or crowded radially.

Vessel lines: Very numerous; fine and inconspicuous.

Vessel contents: None observed.

Rays: Fine and numerous, but readily visible, on cross section; invisible on the tangential; very distinct, though not conspicuous, on the radial, being lighter than the background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits small. Rays heterogeneous; one to three cells wide and greatly variable in height; pits into vessels small, half-bordered, often in reticulate arrangement. Parenchyma in uniseriate, broken tangential rows. Wood fibers with bordered pits.

Remarks: The wood is of about the consistency of red gum (*Liquidambar*), though of harsher feel and somewhat greater density.

Material: Yale Nos. 376, 713, 1615 (Col.); 2696 (P. R.); 1934, 3251*, 3531, 3952* (Braz.); 6213 (Arg.); 2993* (Pan.); 5003, 5003A (Cuba). Asterisk indicates botanical material.

SICKINGIA

The trees of this genus are called "arariba" in Rio de Janeiro, Brazil, and should not be confused with the "araribá," the name applied to certain species of *Centrolobium* (Leguminosae). According to the Rebouças,[254] "arariba branca," *Sickingia viridifolia* K. Sch. (= *Pinckneya*

[254] Rebouças, André e José: *Ensaio de indice geral das madeiras do Brazil*, Rio de Janeiro, 1877, pp. 92-93.

viridifolia Sald. & All.) is a tree in Rio de Janeiro 40 to 50 feet high and 16 to 20 inches in diameter, supplying a porous wood with a specific gravity of about 0.75 and of a dingy white or yellowish color. It is considered of second quality and is used for civil construction and joinery. The "arariba vermelha," *S. rubra* K. Sch. (= *Pinckneya rubescens* Sald. & All.), is slightly larger and has a more compact wood that assumes a beautiful purplish-red color upon exposure to the air. The quality and uses are said to be the same as in the other species.

S. tinctoria (H. B. K.) K. Sch. is a small tree of the Amazon forest, known as "arariba" or "arareua." Small lots of the timber, called "arariba rosa," entered the New York market during the war for use as a dyewood. The species grows also in Venezuela and is the source of a yellow dye. The wood is well suited for objects of turnery.

THE WOOD

Sickingia sp. *Arariba.*

Common names: Arariba, arariba vermelha, arariba rôxo, arariba rosa, arareua (Braz.); paraguatán (Venez.); coloradito ?, candelillo ? (Col.).

General properties: Color brown or yellowish on surface; rose, deep rose, or purplish within; sometimes variegated; luster rather low. Sapwood not sharply defined.

Without distinctive odor; taste rather bitter.

Hard and heavy. Sp. gr. (air-dry) 0.88. Weight about 55 lbs. per cu. ft. Grain fairly straight to somewhat roey. Texture rather fine and uniform; of about the consistency of dogwood (*Cornus florida* L.). Strong, but somewhat brittle, not easy to cut; finishes smoothly; deeply colored specimens look durable.

Growth rings: Fairly distinct to indistinct; due to slight differences in density and in color and sometimes also to parenchyma.

Parenchyma: Inconspicuous; sometimes visible in poorly defined concentric lines, which may be close together but usually are widely spaced.

Pores: Very small; not visible without lens; fairly numerous, but not crowded; occurring singly or more often in radial groups of two or three.

Vessel lines: Fine and indistinct.

Vessel contents: No deposits or tyloses noted.

Rays: Fine, but readily visible, on cross section; invisible on tangential; very distinct on radial, being of deeper color than background.

Ripple marks: Absent.

Gum ducts: None observed.

Minute anatomy: Vessels with simple perforations; pits small, abundant. Rays heterogeneous; one to four cells wide and few to 30 cells high; pits into vessels half-bordered. Parenchyma very sparingly developed. Wood fibers with simple or indistinctly bordered pits; some of the cells septate and, in sapwood, contain starch grains.

Remarks: Is somewhat like "quina" (*Aspidosperma* sp.), but has more prominent rays. The woods from Bahia, Brazil, are not distinguishable from that of the Venezuelan species.

Material: Yale Nos. 3566, 3582, 3638 (Braz.); 436 (Venez.).

MISCELLANEOUS

Standley[255] has recently established two new genera, namely *Calderonia* and *Exandra*, from material obtained in Salvador. *E. rhodoclada* Standley is a shrub or small tree, known locally as "brasil" or "limpiadientes." The wood assumes a red coloration upon exposure to the air and is said to be of good quality for lumber.

Calderonia salvadorensis Standley is described as a tree 15 to 50 feet high, with slender trunk and smooth whitish bark, growing in Salvador and Guatemala. The common names are "campeche," "brasil," "palo colorado," "drago," and "sangre de chucho" (dog's blood). Standley says (*loc. cit.*, p. 291): "The wood is said to be of good quality and is employed for building purposes and for firewood. By its peculiar color it is easily recognized. This red coloration is a property of other woods produced by the same family, as, for instance, *Genipa Maxonii* Standl., of Panama. Dr. Calderón in a recent letter says: 'Lately I saw the wood used for rafters in a country house being built near Sonsonate, and in a building under construction in that city. Some time ago on the shore of Lake Olopango, at a locality known as Apulo, I saw a large quantity of sawed timbers at least 45 cm. wide and seven meters long or more, of pink wood, to which the name "quina" was given. I do not know whether the tree from which they were obtained was the same as my No. 761 [the type tree], but the appearance of the wood was identical. The trees which I have seen are smaller, but in the wild state it would not be strange to find them large enough to give lumber of the dimensions I have described.' The name 'quina' (quinine), it may be remarked, is one often given in Salvador and elsewhere in Central America to Rubiaceous trees because their bitter bark is employed locally in place of the imported quinine."

75. COMPOSITAE

The Asterwort Family consists of about 800 genera and over 12,000 species widely distributed over the world. They are nearly all herbaceous plants, of which the aster, goldenrod, sunflower, and dandelion are familiar examples. Some of the genera contain woody plants, but very rarely do they attain tree size and in no known instance do the woods

[255] Standley, Paul C.: *Calderonia* and *Exandra*, two new genera of the family Rubiaceae, *Journ. Wash. Acad. Sci.*, 13: 13: 289-293, July 19, 1923.

enter the larger markets, though some of them are used locally, particularly in regions where larger timber is not available.

The "tatascame," *Perymenium strigillosum* Greenman, of Central America, is a medium-sized tree 30 to 40 feet high, with a straight clear trunk 12 to 15 feet long and eight to 15 inches through. It grows in the hilly regions, usually above 1000 feet elevation, often in nearly pure stands or, toward its upper limits, in mixture with oak. The wood is of a very light yellowish color, sometimes slightly tinged with red, is only moderately hard and heavy, straight-grained and easily worked, having many of the properties of chestnut (*Castanea*). It is ring-porous, with one or two rows of larger pores in the early wood and numerous small ones in the other portion of the growth ring. The rays are large enough to give a distinct figure on quarter-sawn material. The sapwood is very thin and the heartwood is durable. It is used locally for fence posts, corner posts and other timbers of houses, and yields a charcoal of high calorific intensity. It is believed that this wood is available in sufficient quantity and possesses the requisite properties to give it commercial possibilities. *P. grande* Hemsl., the "tatascame" or "tisate" of Salvador, is said to be a common tree of the mountains, supplying a wood much used for building purposes. It appears that the name "tatascame" is also applied there to *Lippia myriocephala* Schl. and Cham.

The "ocotillo," *Gochnatia hypoleuca* Gray, of northern Mexico, is a small tree yielding a rich brown wood, very heavy and hard, and used locally for fuel and charcoal. In the Galapagos Islands, *Scalasia pedunculata* Hook. forms dense stands of trees 40 to 60 feet high, with large umbrella-like crowns, and is of some local importance.

There are various aborescent genera in Brazil, where they are generally known as "cambará" or "candeia," and, while the trees are small, the fact that they are common in regions where other tree growth is scarce gives them considerable local value for fuel, charcoal, fencing material, and occasionally for lumber used in general carpentry and construction. The more important genera are *Piptocarpha, Lichnophora, Moquinia, Vernonia,*[256] and *Eupatorium.* Trees of the first two reach a height of 25 to 30 feet with diameters of eight to 12 inches. Their woods are of a rich brown color, hard, heavy, compact, strong, and durable, and are used to some extent in carpentry and joinery, but more especially for turnery; also to a limited extent for gunstocks. They are highly resistant to decay and make excellent fence posts and house posts, and are unsurpassed for fuel and charcoal. The bark is used for tan-

[256] Two species of *Vernonia* reach tree size in Salvador and furnish some timber for fuel and for house frames. The common names are: Barreto, rájate bien, rájete luego, sauquillo, suquinay, suquinay prieto.

ning. The leaves of *Eupatorium laeve* DC., upon maceration and subsequent fermentation, give a blue dye which can be used as a substitute for indigo. The "tameague" of Salvador, *E. hebebotryum* (DC.) Hemsl., is said to furnish some timber for construction purposes.

The "aliso del río" or "bobo" of Argentina and Paraguay, *Tessaria* sp., is a small evergreen tree that springs up in dense thickets and grows rapidly on bars formed by the rivers after each freshet, often in association with willow (*Salix Humboldtiana* Willd.). The slender stems are used for roof timbers and in building the walls of native houses. The wood is very light and soft.

The "arboloco" of Colombia, *Montanoa* sp., is an erect tree, sometimes 35 feet high, with a very large pith which may decay and leave the stem hollow. In a specimen (Yale No. 5893) supplied by Mr. Jorge Pinzón C., of Bogotá, the average diameter of the stem is four inches and the pith is an inch and a half thick. The wood is light brown, rather hard and heavy, with rays that are rather narrow, but very conspicuous on radial surface. The timber is used locally in the round for construction.

LIST OF THE YALE COLLECTIONS OF TROPICAL AMERICAN WOODS WHICH WERE STUDIED IN THE PREPARATION OF THIS BOOK

WOOD COLLECTIONS

The serial numbers are those of the Yale catalogue.

The asterisk indicates that botanical material was collected along with the wood samples.

Southern Florida	
*5179-5231 and misc.	Morris K. Jesup and Tenth Census Collections.
Cuba	
725-831	Exhibit at St. Louis Exposition, 1904.
2115-2131	Mr. E. Duque Estrada, Havana.
4985-5019	Prof. Henry S. Graves, New Haven, Conn.
*4936-4941 and misc.	Mr. G. C. Bucher, Santiago.
Misc. trade samples	New York dealers.
Porto Rico	
2685-2723	Mr. Johansen, through Prof. I. W. Bailey, Cambridge, Mass.
4518-4670	?
Haiti	
*4800-4879	Mr. E. C. Leonard, through U. S. National Museum.
Dominican Republic	
5020-5071	Mr. W. D. Durland, Campello, Mass.
5974-5985	Mr. John Foley, Philadelphia, Pa.
*7039-7115	Dr. W. L. Abbott, through U. S. National Museum.
Mexico	
*2942-2943	Dr. H. N. Whitford, New Haven; from Tres Marias Island.
*4731-4740; *5244-5252	Mr. John A. Gamon, Acapulco; from Tecpan de Galeano.
*4758-4771	Mr. B. P. Reko, Oaxaca, through U. S. National Museum.
6166-6197	Mr. H. C. Kluge, Schenectady, N. Y.; from Campeche and Isthmus of Tehuantepec.
*6979-6998	Mr. C. D. Mell; from Tampico.
Guatemala-Honduras	
*3670-3745	Dr. Whitford and Mr. L. R. Stadtmiller; from along eastern portion of boundary.

Honduras	
1-317	Exhibit at St. Louis Exposition, 1904.
6627-6642	Mr. P. H. Myers, Puerto Cortes.
Nicaragua	
5232-5242 and misc. (Two with bot. material)	Messrs. E. Palazio & Co., Corinto.
Costa Rica	
*4350-4374 and misc.	Prof. W. W. Rowlee, Ithaca, N. Y.
6086-6138	Mr. H. T. Purdy, through Professor Rowlee; from southern coast.
Panama	
*2954-3025	Dr. Henry Pittier, Caracas, Venez.; from Canal Zone.
4305-4349	Messrs. Richard Levering & Co., Inc., New York; from southern coast.
5958-5973	Commercial Museum, Philadelphia.
*6733-6750	Dr. Alvin G. Cox, Los Angeles, Calif.; from northern coast.
*7116-7148	Mr. Kluge; near Chepo.
Misc. trade specimens	New York dealers.
Colombia	
373-378	Mr. Abuchar Hermanos, Baranquillo, through Dr. H. N. Whitford, New Haven, Conn.
379-393	Dr. Whitford; from Aseradero "El Liston," Bogatá.
394-403	Dr. Whitford; trade samples, Medellin.
*404-431	Dr. Whitford and Mr. J. Pinzón C.; from along Magdalena and Negro Rivers.
500-517	Mr. H. M. Curran, Raleigh, N. C.; trade samples.
*1515-1623; *3960-3970	Mr. Curran; from San Martin de Loba.
2532-2616	Mr. José Miguel de la Calle, Medellin.
Misc. trade samples	New York dealers.
Curaçao and Venezuelan Coast	
*2132-2164; *2732-2941	Messrs. H. M. Curran and Miles Haman.
Venezuela	
318-364; *432-475	Dr. H. N. Whitford; from vicinity of Puerto Cruz.
2656-2684	Dr. J. N. Rose, Washington, D. C., through Prof. I. W. Bailey, Cambridge, Mass.
4412-4431	Mr. O. Stelling, Caracas.
6643-6683	Dr. H. Pittier, Caracas.
Misc. trade specimens	New York dealers.

British Guiana	
3026-3052	Mr. C. D. Mell, New York.
4203-4227	Prof. J. B. Harrison, Georgetown, through Dr. Whitford.
*4959-4963	Mr. L. S. Hohenkerk, Georgetown.
*5072-5128	Forestry Branch, B. G. Dept. Lands and Mines, Georgetown.
Dutch Guiana	
4160-4188	Forestry Department, through Dr. Whitford.
4189-4204A	Mr. W. Hoogerhuys, Paramaribo, through Dr. Whitford.
*4942-4953	Mr. J. W. Gonggrijp, Paramaribo.
4954-4958	Mr. Gonggrijp; teredo-infested timbers from Saramacca.
French Guiana	
5363-5403	Commandant A. Bertin, through Mr. A. W. Betts, New York.
6352-6401	Mr. A. W. Betts; mostly collected in forest near Guizambourg and Regina.
Ecuador	
1819-1842	Prof. Wm. H. Brewer.
Argentina	
518-529	Mr. Curran; trade samples from Buenos Aires.
*891-1141	Mr. Curran; from region north of Buenos Aires and especially in Misiones.
1687-1741; 3971-4002	Exhibit at Panama-Pacific Exposition in San Francisco, through Mr. Curran.
*1742-1776	Mr. Max Rothkugel, from Patagonia; through Mr. Curran.
6199-6261	Exhibit at Philadelphia Centennial Exposition, distributed by U. S. Dept. Agr.; through Prof. Rowlee.
Chile	
3750-3770	Ministerio de Industria, through Prof. G. R. Wieland, New Haven, Conn.
5543-5560	Michigan Agr. College, through Prof. G. A. Garratt.
Brazil	
592-661	Mr. P. P. Demers, Bahia, through Mr. Curran.
677-724	Mr. Curran; trade samples from Rio de Janeiro.
1451-1490	From Rio del Velhas, Minas Geraes.
*1777-1815; 1925-1945; 3940-3956; 4671-4730	Mr. Curran; from Rio Grongogy Basin, Bahia.

Brazil (continued)

2492-2521	Mr. Eugene Horn; from São Paulo.
3101-3120	Messrs. Alves Vasconcellos, Rio de Janeiro, through Dr. Whitford.
*3121-3180	Mr. Octavio Vecchi, São Paulo, through Dr. Whitford.
3181-3230	Dr. Whitford; trade samples, Espirito Santo.
3231-3249	Messrs. J. Charvolin & Co., São Paulo, through Dr. Whitford.
*3250-3289	Dr. Whitford; from Collatina, Espirito Santo.
*3290-3298	Dr. Whitford; from Tres Barros, Santa Catharina.
3301-3319	Dr. Whitford; misc. trade samples.
*3350-3662	Mr. Curran; from Pará, Bahia, and Rio de Janeiro; many trade samples included.
3890-3937	Misc. specimens from São Paulo and Amazon region.
*4003-4051	Dr. J. Huber, Pará, through Dr. Farabee and Prof. I. W. Bailey.
4228-4303	Mr. Henry J. McCall, Catete, Bahia, through Mr. E. C. M. Richards, New York.
4375-4400	Messrs. Goodell-Pratt Co., Greenfield, Mass.; from southern Matto Grosso.
5405-5542	Michigan Agr. College, through Professor Garratt; from Rio de Janeiro and Campos regions.
5905-5921	Mr. C. H. Pearson, New York; from Rio de Janeiro and Amazon.
5942-5957	Dr. Martin and Mr. A. A. Smith, through Mr. W. K. Wildes, N. Y.; from Amazon region.
5990-6085	Philadelphia Centennial Exposition, through Prof. W. W. Rowlee, Ithaca, N. Y.
The "L. Agassis" col.	A collection of 100 woods inscribed "A Mr. le profeur L. Agassis ses amis de l'Amazone"; loaned by Prof. I. W. Bailey, Cambridge, Mass.
Misc. trade samples	Messrs. C. H. Pearson, A. W. Betts, H. T. Dayton, Astoria Veneer Mills, and others, New York.

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